USDA United States Department of Agriculture

NRCS Natural Resources Conservation Service

In cooperation with United States Department of Interior, National Park Service and the Utah Agricultural Experiment Station

Soil Survey of Natural Bridges National Monument, Utah

How To Use This Soil Survey

General Soil Map

The general soil map, which is a color map, shows the survey area divided into groups of associated soils called general soil map units. This map is useful in planning the use and management of large areas.

To find information about your area of interest, locate that area on the map, identify the name of the map unit in the area on the color-coded map legend, then refer to the section **General Soil Map Units** for a general description of the soils in your area.

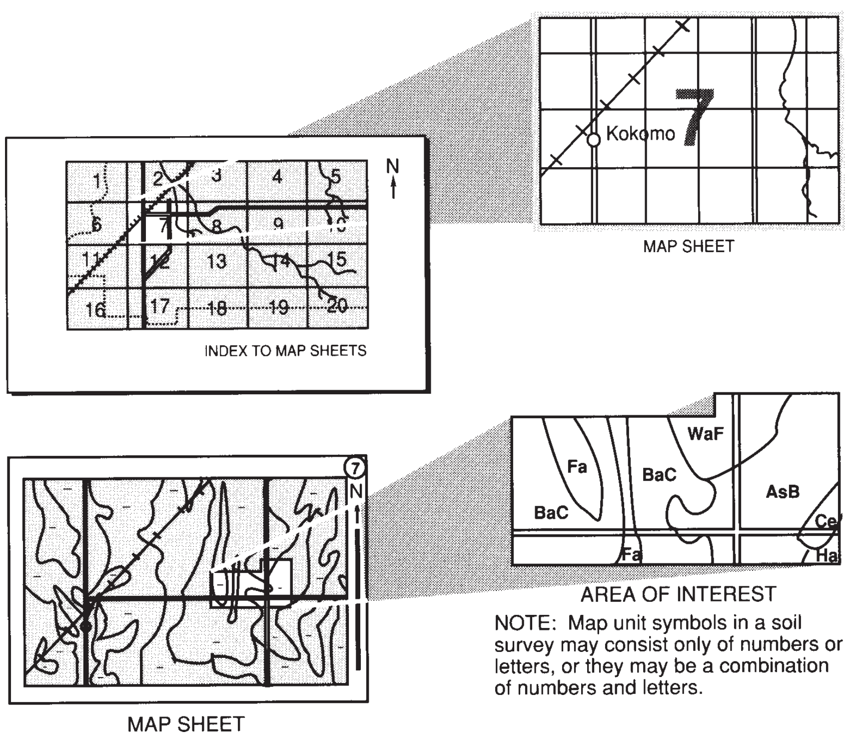
Detailed Soil Maps

The detailed soil maps can be useful in planning the use and management of small areas.

To find information about your area of interest, locate that area on the **Index to Map Sheets**. Note the number of the map sheet and turn to that sheet.

Locate your area of interest on the map sheet. Note the map unit symbols that are in that area. Turn to the **Contents**, which lists the map units by symbol and name and shows the page where each map unit is described.

The **Contents** shows which table has data on a specific land use for each detailed soil map unit. Also see the **Contents** for sections of this publication that may address your specific needs.



This soil survey is a publication of the National Cooperative Soil Survey, a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local agencies. The Natural Resources Conservation Service (formerly the Soil Conservation Service) has leadership for the Federal part of the National Cooperative Soil Survey.

Major fieldwork for this soil survey was initiated in 2005, and completed in 2007. Soil names and descriptions were approved in 2008. Unless otherwise indicated, statements in this publication refer to conditions in the survey area in 2007. This survey was made for Natural Bridges National Monument, Utah, by the Natural Resources Conservation Service in cooperation with the National Park Service.

The correct citation for this soil survey is as follows: United States Department of Agriculture, Natural Resources Conservation Service. 2009. Soil Survey of Natural Bridges National Monument, Utah. Accessible online at: http://soils.usda.gov/survey/printed_surveys/.

Cover: View of Owachomo Bridge from Armstrong Canyon in Natural Bridges National Monument, showing map units 72 and 73.

Additional information about the Nation's natural resources is available online from the Natural Resources Conservation Service at http://www.nrcs.usda.gov.

Contents

Issued 2011

Foreword

This soil survey was developed in conjunction with the National Park Service Inventory and Monitoring Program and is intended to serve as the official source document for soils occurring within Natural Bridges National Monument.

This soil survey contains information that affects current and future land use planning in the park. It contains predictions of soil behavior for selected land uses. The survey also highlights soil limitations, actions needed to overcome the limitations, and the impact of selected land uses on the environment.

This soil survey is designed to meet the needs of the National Park Service and their partners to better understand the various soil properties present in the park and their affect on various natural ecological properties to help them understand, protect, and enhance the environment.

The information in this report is intended to identify soil properties that are used in making various land use or land treatment decisions. Statements made in this report are intended to help the land users identify and reduce the effects of soil limitations on various land uses.

Great differences in soil properties can occur within short distances. Some soils are seasonally wet or subject to flooding. Some are shallow to bedrock. Some are too unstable to be used as a foundation for buildings or roads. Clayey, sandy, or wet soils are poorly suited to use as septic tank absorption fields. A high water table makes a soil poorly suited to basements or underground installations. These and many other soil properties that affect land use are described in this soil survey. Broad areas of soils are shown on the general soil map. The location of each soil is shown on the detailed soil maps. Each soil in the survey area is described. Information on specific uses is given for each soil.

Help in using this publication and additional information are available at the local office of the Natural Resources Conservation Service or the Cooperative Extension Service, as well as the National Park Service Natural Resources Program Center.

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Soil Survey of
Natural Bridges National Monument, Utah

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United States Department of Agriculture, Natural Resources Conservation Service, in cooperation with United States Department of Interior, National Park Service, and the Utah Agricultural Experiment Station.

General Nature of the Survey Area

Natural Bridges National Monument is located in San Juan County in southeastern Utah, and consists of 7,636 acres (30.9 square kilometers) (fig. 1). The Monument, the first National Park Service unit in Utah, was established in 1909 by President Theodore Roosevelt to preserve and protect the geologic and archaeological resources of the area. The area is irregular in shape and consists mainly of a mesa top and two narrow canyons.

Natural Bridges National Monument is located on the northern edge of Cedar Mesa and is cut through by Armstrong and White Canyons, which contain three natural bridges and masonry structures constructed by ancestral Puebloan people. A nine-mile paved loop road provides access to scenic overlooks and hiking trails within the Monument.

The Monument can be accessed by Utah State Road 275, which connects to Utah Highway 95 between Blanding and Hite Marina. The closest towns to the Monument are Blanding, Utah (population 3,185), 70 miles to the east; Bluff, Utah (population 320), 61 miles to the southwest; and Hanksville, Utah (population 362), 88 miles to the west. The areas between these towns and the Monument are extremely rural, with widely scattered ranches.

An older survey, “Soil Survey of San Juan County, Utah, Central Part,” was published in 1993 (USDA, 1993). This earlier survey covers a part of the present survey area. The present survey updates the earlier survey and provides additional information.

Physiography

Natural Bridges National Monument is located in the Canyon Lands section of the Colorado Plateau, north-central portion. The Monument is situated on the northern

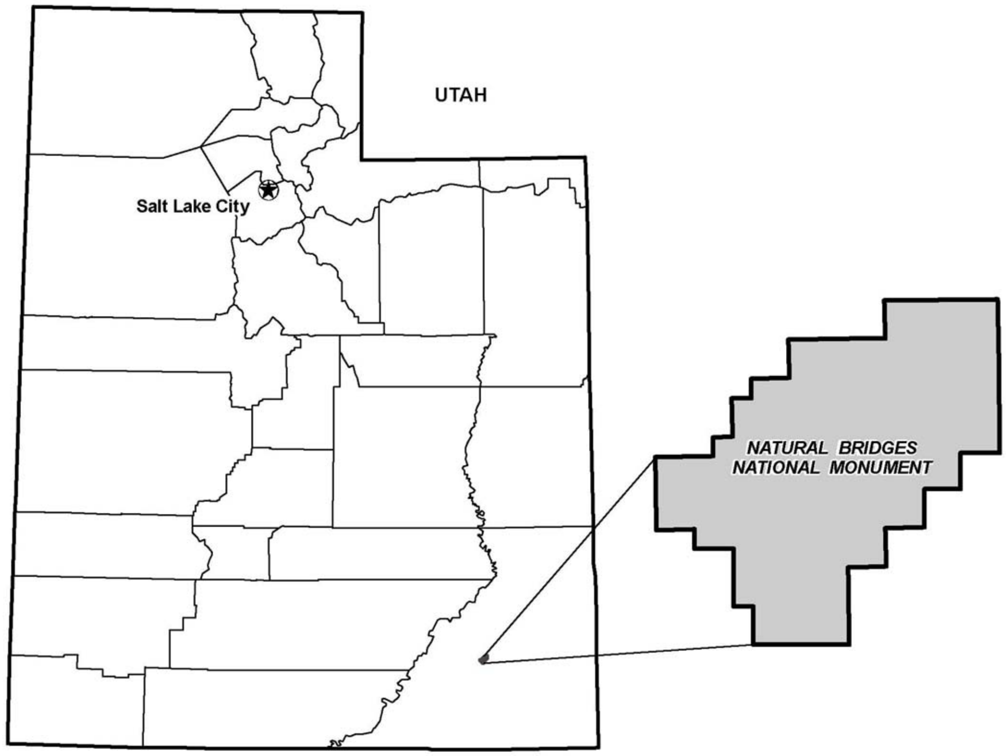

Figure 1.—Location of Natural Bridges National Monument in Utah.

edge of Cedar Mesa, a prominent physiographic feature of the area. White Canyon enters the Monument from the northeast corner of the park and is joined by Deer Canyon from the north. Armstrong Canyon enters the Monument from the southeast corner of the park and is joined by Tuwa Canyon from the east. Armstrong and White Canyons join just east of the western boundary of the Monument. The canyons reach a depth of approximately 500 feet (150 meters) in places. They cut through this portion of Cedar Mesa, which within the Monument varies in elevation from nearly 6,700 feet (2,043 meters) near the eastern boundary, to about 5,800 feet (1,768 meters) in the west. This portion of Cedar Mesa slopes predominantly west. Water sources in the Monument are primarily seasonally intermittent in the bottoms of canyons, with a few spring-supplemented perennial pools in Armstrong Canyon.

Climate

Table 1 gives data on temperature and precipitation for the survey area as recorded at Natural Bridges National Monument in the period 1971 to 2000 (National Water and Climate Center, 2009). Table 2 shows probable dates of the first freeze in fall and the last freeze in spring. Table 3 provides data on length of the growing season in the period 1965 to 1990. Extremes and averages mentioned in the narrative are based on the entire period of record, 1965 to 2006.

In winter, the average temperature is 31.1 degrees F (-0.5 degrees C), and the average daily minimum temperature is 20.4 degrees F (-6.4 degrees C). The lowest temperature on record, which occurred on December 22, 1990, is -14 degrees (-25.6 degrees C). In summer, the average temperature is 71.4 degrees (21.9 degrees C), and the average daily maximum temperature is 86.5 degrees (30.3 degrees C). The

highest recorded temperature, which occurred on July 13, 1971, is 103 degrees (39.4 degrees C).

The total annual precipitation is about 12.5 inches (31.9 centimeters). Of this, 6.2 inches (15.89 centimeters), or 50 percent, usually falls in April through September. The growing season for most crops falls within this period. The average seasonal snowfall is about 40.0 inches (101.6 centimeters). The greatest snow depth at any one time during the period of record was 28 inches (71.1 centimeters).

Vegetation

Natural Bridges National Monument falls within Major Land Resource Area (MLRA) 36 – Southwestern Plateaus, Mesas and Foothills (USDA, 2006). MLRA 36 occurs in New Mexico (58 percent), Colorado (32 percent), and Utah (10 percent). It makes up about 23,885 square miles (61,895 square kilometers). The major towns in the area are Cortez and Durango, Colorado; Santa Fe and Los Alamos, New Mexico; and Monticello, Utah. Mesa Verde National Park and Bandelier, Hovenweep, Natural Bridges, Yucca House, and Colorado National Monuments are in the area.

Currently in Utah, MLRA 36 is not subdivided by land resource units (LRUs). Most of the area is characterized by generally horizontal beds of Jurassic, Cretaceous, and Tertiary sedimentary rocks. The sedimentary rocks have been eroded into plateaus, mesas, hills, and canyons. In the Natural Bridges vicinity, the Organ Rock Member of the Cutler Group and Cedar Mesa Formation Sandstone, both from the Permian period, dominate the landscape.

At Natural Bridges National Monument, the annual mean precipitation is approximately 12.5 inches (31.9 centimeters). However, the annual precipitation can range from 6 to 19 inches (15 to 48 centimeters). Much of the rainfall occurs as convective storms in late summer; about 20 to 35 percent of the total precipitation falls in July and August. About 15 to 25 percent of the precipitation is snow. Snowpacks are generally light and not persistent throughout the winter, except at the higher elevations. The average annual temperature ranges from 37 to 63 degrees F (3 to 17 degrees C). The frost-free (<32°F) period averages 140 days and ranges from 120 to 170 days. The soil temperature regime is mesic, and the soil moisture regime is aridic ustic.

On uplands above the canyon rim, the dominant plant species include twoneedle pinyon, Utah juniper, and big sagebrush, with a sparse understory of Indian ricegrass and forbs. More towards the rim, on the shallow soil intermixed with rock outcrop, the common plants include twoneedle pinyon, Utah juniper, and littleleaf mountain mahogany with an understory of perennial bunch grasses and forbs. The soil found on steep canyon walls most often supports a mix of twoneedle pinyon and Utah juniper with a robust mix of Utah serviceberry, mountain mahogany, roundleaf buffaloberry, and perennial grasses, including Indian ricegrass and Salina wildrye. In protected north-facing slopes, Douglas fir can be present. On the flood plains and riparian corridors within the canyons, the dominant plant species include cottonwood, willows, phragmites, rabbitbrush, and forbs. On the flood-plain steps and terraces above the current floodplain, dominant plants include rabbitbrush, basin big sagebrush, Gambel oak, and scattered Utah juniper, with an understory dominated by Indian ricegrass and needle and thread.

Geology

Stratigraphy and Sedimentology

In Natural Bridges National Monument, the rocks exposed consist almost entirely of Permian-aged formations, with very limited exposures of Triassic formations in the

westernmost area of the monument. Quaternary-aged alluvium is present in the bottom of the canyons. This represents a time period for the bedrock of 60 million years, from 290 million years ago at the bottom of the Permian to approximately 230 million years ago for the bottom of the Chinle Formation of the Triassic period (fig. 2) (Huntoon et al., 2003).

Permian Period

Lower Cutler Beds

The Lower Cutler Beds are not exposed within the Monument, but are present elsewhere on Cedar Mesa. These beds consist of sandstone, mudstone, and limestone.

Cedar Mesa Sandstone

Almost all rocks exposed in the Monument are of the Cedar Mesa Sandstone Formation. These rocks are white to gray sandstones, very fine to fine-grained, with thin beds of red mudstone and very fine-grained sandstone. In the Monument, the dominant facies is the white sandstone. The red mudstone and sandstone facies are overlain and underlain by the white sandstone, and occur as thin beds within it.

The white sandstone facies consists of quartz-rich sandstones. Rarely are fossils detected in the sandstone. The crossbeds in this sandstone are high-angle and large-scale. The cross-bedding features are believed to be the result of deposition by very large migrating eolian sand dunes.

The red mudstone facies consist of laminated beds 1 to 10 feet thick. They occur throughout the thicker sections of white sandstone in the Monument. The mudstone in this facies is micaceous, and the red sandstone within it is very fine grained. Fossiliferous limestone layers are rarely present. The red mudstone layers are usually massive, and are believed to have been formed during floods that covered the dune surfaces and interdune areas, leaving behind nearly continuous layers that extend for miles. Some of the mudstone layers contain sand-filled cracks from the overlying dune areas.

Organ Rock Formation

The small exposure of Organ Rock is in the western part of the Monument. It is the youngest formation of the Cutler Group in the region. It is a reddish-brown to light-red slope-forming unit. It is made up of feldspar-rich very fine to fine grained sandstone, siltstone, and mudstone. There are also minor amounts of carbonate-pebble conglomerate constituents. The environments in which this formation had its origins include marine mudflats, tidal channels, and fluvial systems, including floodplain deposits.

Triassic Period

Moenkopi Formation

The Lower Triassic Moenkopi Formation abuts the western edge of the Monument, overlying the Organ Rock Formation. Since these two formations are both red, the contact is difficult to identify near the Monument. The lower part of the Moenkopi is composed of very coarse to medium-sized quartz grains, which contrast with the very fine and fine grains of the Organ Rock Formation, the distinction being an indicator of the contact between the two.

The Moenkopi is composed of reddish-brown sandstone, siltstone, and mudstone, and may contain chert-pebble conglomerate. It was deposited in fluvial channels and floodplains, marine mudflats and tidal channels, and marine environments. It varies from 300 to 400 feet thick in the area. It forms a reddish-brown slope between the Chinle Formation above it and the Organ Rock Formation below.

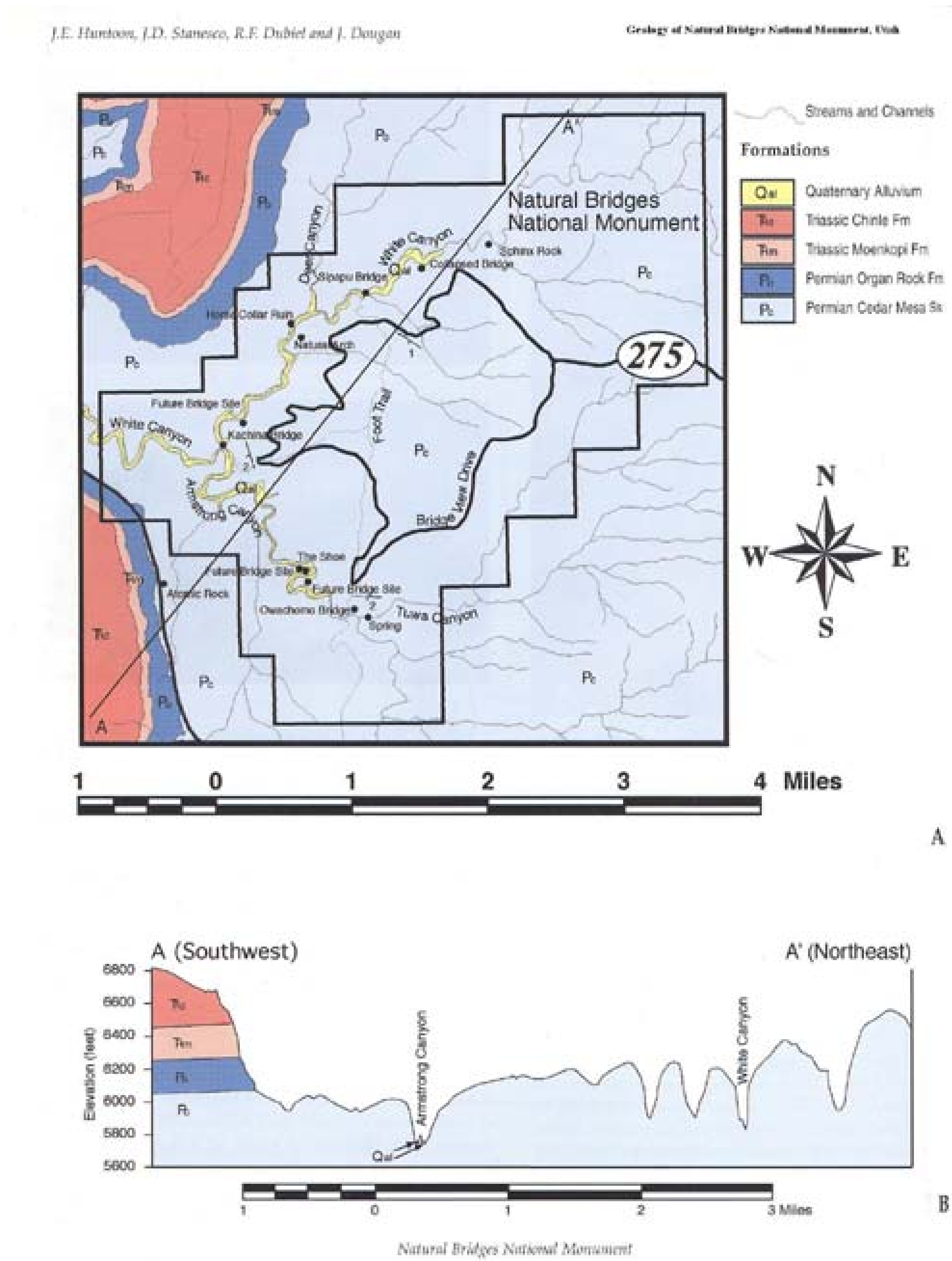

Figure 2.—Geology map of Natural Bridges National Monument (Huntoon et al., 2003).

Chinle Formation

The Chinle Formation lies just outside the western boundary of the Monument, and directly overlies the Moenkopi Formation. It consists of the Shinarump Conglomerate Member (the lowest member), composed of gravel-sized chert and quartz gravels laid down by fluvial systems which eroded ancient valleys into the underlying Moenkopi Formation. The remainder of the Chinle is composed of sediments deposited in fluvial channel, floodplain, marsh, and lake systems. Chinle forms a pastel-colored slope above the Moenkopi Formation (Huntoon et al., 2003).

Natural Bridge Formation

The formation of natural bridges is governed by the processes of running water, as opposed to the role of wind in natural arch formation. The formation of the bridges in the Monument began when streams formed on the surface of the Cedar Mesa Sandstone. These streams downcut through the geology as a result of uplift of the Colorado Plateau and lowering of the elevation of the channel of the Colorado River.

Often, meanders of these streams in and around the Monument were separated by walls of sandstone. Some of the thinner sections of these sandstone walls eventually were worn away, and the river flowed through the wall. This became a natural bridge, and the meanders were abandoned (Huntoon et al., 2003).

Soils Overview

The soils in the Monument can be divided into three major groups based on origin: eolian deposits on the mesa top, canyon ledges, and structural benches; colluvial deposits on canyon walls, escarpments, and talus slopes; and alluvial deposits in the canyon bottoms.

The soils on the main mesa top in the Monument are eolian in origin. They vary in depth from a few centimeters to well over 2 meters in depth. In general, the deepest soils are concentrated in the interior (soil map unit 69), the shallower soils occur nearer the edges of the mesa (soil map unit 71), and the zone between these two map units is a period of transition and accelerated erosion (soil map unit 70). These eolian soils are the result of episodic deposition over a long period of time; some nearby samples in Canyonlands National Park have been dated to 46,000 years ago, with depositional events continuing up to the present day in varying degrees of intensity (Reynolds et al., 2006). The same research concluded that soil development occurred for at least a few thousand years before being interrupted by new depositional activity.

Two deep eolian soils have been mapped in the Monument. The Nomrah series is a well-developed soil with an argillic horizon (evidence of translocated clay) and a calcic horizon (accumulation of carbonates). The development of these pedogenic horizons requires a considerable amount of time and relative stability in the landscape. These soils tend to be on the flattest, most interior portions of the mesa. Some pedons show evidence of several discrete periods of soil development, indicating intervals after eolian deposition when the soil was allowed to develop for a period of a few thousand years, followed by another significant depositional event and another period of soil development. This is evidenced by the existence of calcic horizons at two or three different depths in the profile, rather than a discrete zone of carbonate accumulation.

The Plumasano taxadjunct is also a very deep eolian soil on the mesa top. It has a calcic horizon, evidence of relatively long-term stability, which allowed the soil to develop through pedogenic processes. It shows relatively less development than the Nomrah soils, however, with less clay translocation and comparatively coarser textures.

The Tanoan family soils are similar to the Plumasano taxadjunct soils, but can have bedrock at any depth greater than 51 centimeters. The reason for this variability is mainly the position on the landscape. The very deep Plumasano taxadjunct soils occupy interfluves of the highly dissected, rolling landscape of soil map unit 70, whereas Tanoan family soils are on sideslopes of these interfluves. On these sideslopes, significant erosion has taken place, resulting in removal of all or part of the original surface and in variability in depth to bedrock.

Moving further toward the edges of the mesa, the dominant soil in map unit 71 is the Gladel series, with a minor component of the Nizhoni taxadjunct. Both soils are

eolian in origin. Though both soils are shallow, they differ significantly in degree of development. The Nizhoni soils appear to be much “younger,” displaying relatively little evidence of pedogenesis. These soils commonly occupy the interspace regions of the landscape, between the canopy of pinyon or juniper trees. In contrast, the Gladel soils have moderately developed subhorizons, many of which show an accumulation of carbonates and strong soil structure. The Gladel soils tend to be under the canopy of trees and shrubs, and can be assumed to have been stable for relatively longer periods of time compared to the more weakly-developed Nizhoni soils.

Map unit 72 includes the rock outcrop-dominated areas at the edge of the mesa, as well as the cliffs and canyon walls between the mesa top and the canyon bottoms. Once again, eolian soils (predominantly the weakly-developed Nizhoni taxadjunct) are present in this map unit, occupying ledges and structural benches that are large enough for wind-blown sands to accumulate. The other major soil component of this map unit is the Bamac series. These are very deep colluvial soils that occupy talus slopes and escarpments on the walls of the canyons. The parent material of these soils is the Permian-aged Cedar Mesa Sandstone, the dominant geologic formation of the mesa tops and canyon sides. These soils are very steep, and the surfaces are very stony or bouldery. Some areas of these Bamac soils are relatively cooler and more moist, the result of a north-facing aspect and sheltered position under the canyon walls, and these areas support pockets of Douglas fir. The Bamac soils, being in positions on the landscape of relative instability, lack significant pedogenesis and do not have accumulations of clay or calcium carbonate in their profiles.

Map unit 73 occupies the canyon bottoms. The soils in this unit are alluvial in origin, mainly from the local Cedar Mesa Sandstone formation, which makes up the bulk of the watershed into these canyons. The soils in these canyon bottoms are coarse-textured and stratified, and lack significant soil development because of the active depositional environment. Soils of the Levante family are present on flood-plain steps that are frequently flooded and on higher terraces that are occasionally flooded. Evidence of these flooding events is observable in the debris piled high (some as high as 10 meters) in the branches of large cottonwood trees. The active stream channels in the very bottom of the canyons are characterized by highly variable cobbly surfaces and substrates, and generally do not support vegetation. Between the active stream channel and the flood-plain step is a very narrow floodplain. The soils here are frequently flooded and consist of highly variable sandy or sandy-skeletal ustifluvents. Scattered throughout the canyons, there are also small remnants of very high abandoned terraces which no longer flood; these often have a few colluvial stones and boulders on the surface which have fallen from the canyon walls above.

Map unit 74 is a small component of the Monument. The major soil found in this map unit is the Metuck series. Metuck is a shallow soil formed in colluvium from Permian-aged Organ Rock Sandstone, with very steep slopes and a stony or bouldery surface. Because they are colluvial in origin and because the slopes make them relatively unstable, Metuck soils lack significant pedogenic development, such as calcium carbonate accumulation or clay translocation.

How This Survey Was Made

This survey was made in conjunction with the National Park Service’s Soil Inventory and Monitoring Program to provide information about the soils and miscellaneous areas in Natural Bridges National Monument. The information includes a description of the soils and miscellaneous areas and their location, and a discussion of their suitability, limitations, and management for specified uses. Soil

scientists observed the steepness and shape of the slopes; the general pattern of drainage; the kinds of native plants; and the kinds of bedrock. They dug many holes to study the soil profile, which is the sequence of natural layers, or horizons, in a soil. The profile extends from the surface down into the unconsolidated material in which the soil formed. The unconsolidated material is devoid of roots and other living organisms and has not been changed by other biological activity.

The soils and miscellaneous areas in the survey area are in an orderly pattern that is related to the geology, landforms, relief, climate, and natural vegetation of the area. Each kind of soil and miscellaneous area is associated with a particular kind of landform or with a segment of the landform. By observing the soils and miscellaneous areas in the survey area and relating their position to specific segments of the landform, a soil scientist develops a concept or model of how they were formed. Thus, during mapping, this model enables the soil scientist to predict with a considerable degree of accuracy the kind of soil or miscellaneous area at a specific location on the landscape. The approximate percentages of different soils or miscellaneous areas in the different map units was determined using the soil-landscape-landform models developed by extensive ground investigations coupled with remote-sensing tools such as digital elevation models, detailed geology maps, aerial photography, and topographic maps.

Commonly, individual soils on the landscape merge into one another as their characteristics gradually change. To construct an accurate soil map, however, soil scientists must determine the boundaries between the soils. They can observe only a limited number of soil profiles. Nevertheless, these observations, supplemented by an understanding of the soil-vegetation-landscape relationship, are sufficient to verify predictions of the kinds of soil in an area and to determine the boundaries.

Soil scientists recorded the characteristics of the soil profiles that they studied. They noted soil color, texture, size and shape of soil aggregates, kind and amount of rock fragments, distribution of plant roots, reaction, and other features that enable them to identify soils. After describing the soils in the survey area and determining their properties, the soil scientists assigned the soils to taxonomic classes (units). Taxonomic classes are concepts. Each taxonomic class has a set of soil characteristics with precisely defined limits. The classes are used as a basis for comparison to classify soils systematically. Soil taxonomy, the system of taxonomic classification used in the United States, is based mainly on the kind and character of soil properties and the arrangement of horizons within the profile. After the soil scientists classified and named the soils in the survey area, they compared the individual soils with similar soils in the same taxonomic class in other areas so that they could confirm data and assemble additional data based on experience and research.

While a soil survey is in progress, samples of some of the soils in the area generally are collected for laboratory analyses and for engineering tests. Soil scientists interpret the data from these analyses and tests as well as the field-observed characteristics and the soil properties to determine the expected behavior of the soils under different uses. Interpretations for all of the soils are field tested through observation of the soils in different uses and under different levels of management. Some interpretations are modified to fit local conditions, and some new interpretations are developed to meet local needs. Data are assembled from other sources, such as research information, production records, and field experience of specialists.

Predictions about soil behavior are based not only on soil properties but also on such variables as climate and biological activity. Soil conditions are predictable over long periods of time, but they are not predictable from year to year. For example, soil

scientists can predict with a fairly high degree of accuracy that a given soil will have a high water table within certain depths in most years, but they cannot predict that a high water table will always be at a specific level in the soil on a specific date.

After soil scientists located and identified the significant natural bodies of soil in the survey area, they drew the boundaries of these bodies on aerial photographs and identified each as a specific map unit. Aerial photographs show trees, buildings, fields, roads, and rivers, all of which help in locating boundaries accurately. Map unit composition (estimates of component percentages) was determined using a combination of transects on the ground, as well as photo interpretation based on ground-truthed data points.

General Soil Map Units

The general soil map in this publication shows broad areas that have a distinctive pattern of soils, relief, and drainage (fig. 3). Each map unit on the general soil map is a unique natural landscape. Typically, it consists of one or more major soils or miscellaneous areas and some minor soils or miscellaneous areas. It is named for the major soils or miscellaneous areas. The components of one map unit can occur in another but in a different pattern.

The general soil map can be used to compare the suitability of large areas for general land uses. Areas of suitable soils can be identified on the map. Likewise, areas where the soils are not suitable can be identified.

Because of its small scale, the map is not suitable for planning the management of a specific small area or for selecting a site for a road or building or other structure. The soils in any one map unit differ from place to place in slope, depth, drainage, and other characteristics that affect management.

Eolian deposits on mesas

1. Gladel-Plumasano-Rock outcrop association

Map Unit Setting

Landform setting: Mesas and structural benches
Elevation: 5,800 to 6,700 feet (1,768 to 2,042 meters)
Slope: 2 to 15 percent

Map Unit Composition

Extent of the association in the survey area: 53 percent
Extent of the components in the association:
Gladel and similar soils: 59 percent
Plumasano and similar soils: 15 percent
Rock outcrop: 15 percent

Soils of Minor Extent

Nomrah soils on summits of mesa tops
Tanoan family soils on sideslopes and breaks of mesa tops
Shallow and moderately deep soils with petrocalcic horizons on summits of mesa tops
Nizhoni soils on footslopes and structural benches of mesa tops

Component Descriptions

Gladel soils
Position on the landform: Summits and footslopes of mesa tops
Parent material: Eolian deposits derived from sandstone

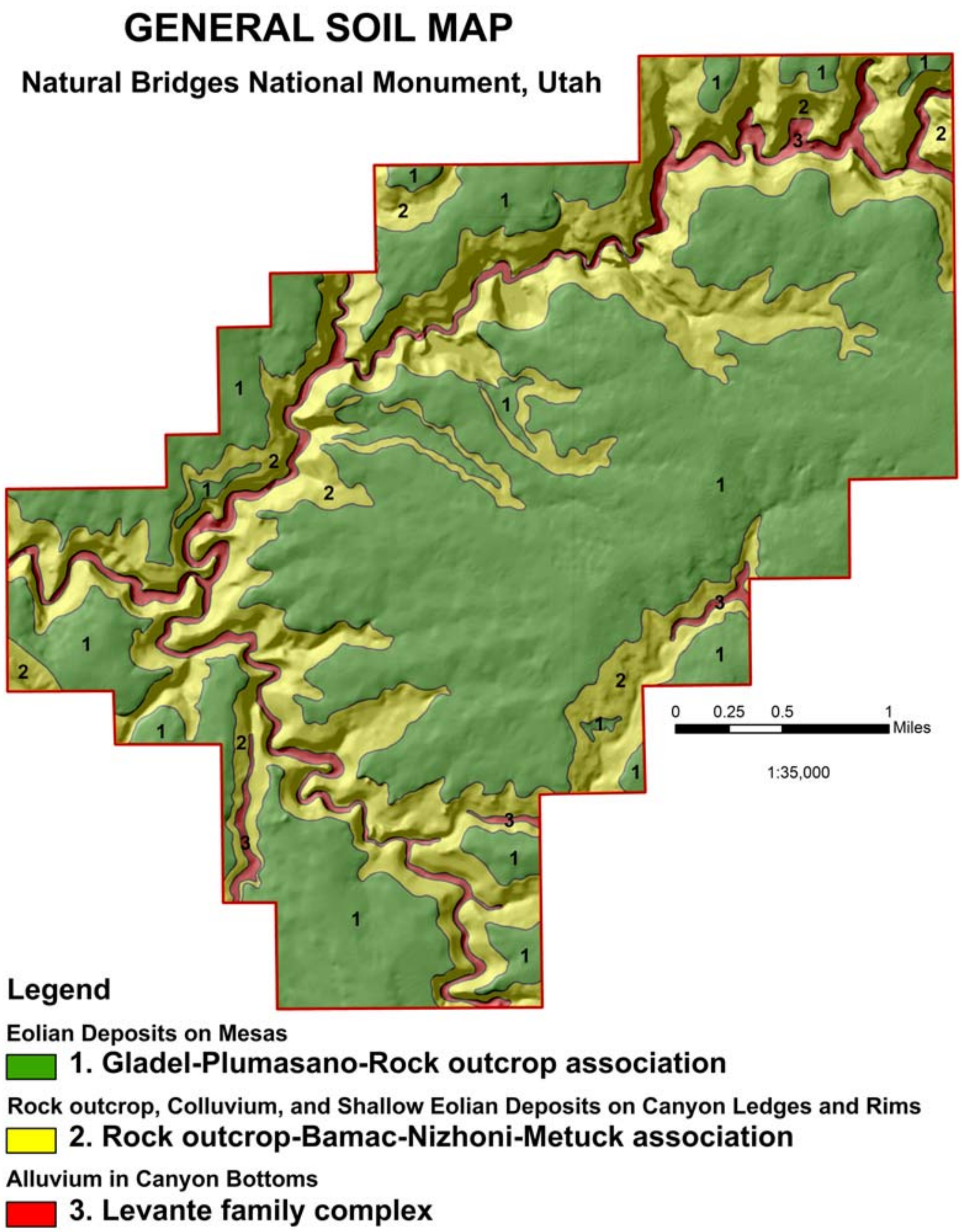

Figure 3.—General soils map of Natural Bridges National Monument.

Depth class: Shallow
Drainage class: Well drained
Permeability: Moderately rapid
Surface texture layer: Fine sandy loam

Plumasano soils
Position on the landform: Summits and sideslopes of mesa tops
Parent material: Eolian deposits derived from sandstone
Depth class: Very deep

Drainage class: Well drained
Permeability: Moderately rapid
Surface texture layer: Loamy fine sand

Rock outcrop
Position on the landform: Drainageways and structural benches of mesa tops
Parent material: Cedar Mesa Sandstone

Rock outcrop, colluvium, and shallow eolian deposits on canyon ledges and rims

2. Rock outcrop-Bamac-Nizhoni-Metuck association

Map Unit Setting

Landform setting: Canyon walls, escarpments, talus slopes, and mesa edges
Elevation: 5,600 to 6,600 feet (1,707 to 2,012 meters)
Slope: 8 to 65 percent

Map Unit Composition

Extent of the association in the survey area: 40 percent
Extent of the components in the association:
Rock outcrop: 59 percent
Bamac and similar soils: 15 percent
Nizhoni and similar soils: 15 percent
Metuck and similar soils: 1 percent

Soils of Minor Extent

Shallow soils with greater than 25 percent surface fragments and slopes greater than 15 percent
Gladel soils on ledges and structural benches

Component Descriptions

Rock Outcrop
Position on the landform: Mesa edges and canyon walls
Parent material: Cedar Mesa Sandstone

Bamac soils
Position on the landform: Talus slopes
Parent material: Colluvium derived from sandstone
Depth class: Moderately deep to very deep
Drainage class: Excessively drained
Permeability: Rapid
Surface texture layer: Gravelly loamy fine sand

Nizhoni soils
Position on the landform: Ledges and structural benches
Parent material: Eolian deposits derived from sandstone
Depth class: Very shallow
Drainage class: Well drained
Permeability: Moderately rapid

Surface texture layer: Loamy fine sand

Metuck soils
Position on the landform: Escarpments and talus slopes
Parent material: Colluvium derived from sandstone
Depth class: Shallow
Drainage class: Somewhat excessively drained
Permeability: Moderate
Surface texture layer: Very gravelly sandy loam

Alluvium in canyon bottoms

3. Levante family complex

Map Unit Setting

Landform setting: Terraces and flood-plain steps
Elevation: 5,600 to 6,200 feet (1,707 to 1,890 meters)
Slope: 0 to 15 percent

Map Unit Composition

Extent of the association in the survey area: 5 percent
Extent of the components in the association:
Levante family and similar soils: 65 percent
Levante family, frequently flooded and similar soils: 20 percent

Soils of Minor Extent

Cobbly riverwash in active stream channels
Sandy or sandy-skeletal Ustifluvents on narrow floodplains
Very deep alluvial soils overlain with colluvium on high abandoned terraces

Component Descriptions

Levante family soils
Position on the landform: High terraces
Parent material: Alluvium derived from sandstone
Depth class: Very deep
Drainage class: Excessively drained
Permeability: Rapid
Surface texture layer: Loamy fine sand

Levante family soils, frequently flooded
Position on the landform: Flood-plain steps
Parent material: Alluvium derived from sandstone
Depth class: Very deep
Drainage class: Excessively drained
Permeability: Rapid
Surface texture layer: Loamy fine sand

Detailed Soil Map Units

The map units delineated on the detailed soil maps in this survey represent the soils or miscellaneous areas in the survey area. The map unit descriptions in this section, along with the maps, can be used to determine the suitability and potential of a unit for specific uses. They also can be used to plan the management needed for those uses.

A map unit delineation on a soil map represents an area dominated by one or more major kinds of soil or miscellaneous areas. A map unit is identified and named according to the taxonomic classification of the dominant soils. Within a taxonomic class there are precisely defined limits for the properties of the soils. On the landscape, however, the soils are natural phenomena, and they have the characteristic variability of all natural phenomena. Thus, the range of some observed properties may extend beyond the limits defined for a taxonomic class. Areas of soils of a single taxonomic class rarely, if ever, can be mapped without including areas of other taxonomic classes. Consequently, every map unit is made up of the soils or miscellaneous areas for which it is named and some minor components that belong to taxonomic classes other than those of the major soils.

Most minor soils have properties similar to those of the dominant soil or soils in the map unit, and thus they do not affect use and management. These are called noncontrasting, or similar, components. They may or may not be mentioned in a particular map unit description. Other minor components, however, have properties and behavioral characteristics divergent enough to affect use or to require different management. These are called minor components. They generally are in small areas and could not be mapped separately because of the scale used. The contrasting components are mentioned in the map unit descriptions. A few areas of minor components may not have been observed, and consequently they are not mentioned in the descriptions, especially where the pattern was so complex that it was impractical to make enough observations to identify all the soils and miscellaneous areas on the landscape.

The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The objective of mapping is not to delineate pure taxonomic classes but rather to separate the landscape into landforms or landform segments that have similar use and management requirements. The delineation of such segments on the map provides sufficient information for the development of resource plans. If intensive use of small areas is planned, however, onsite investigation is needed to define and locate the soils and miscellaneous areas.

An identifying symbol precedes the map unit name in the map unit descriptions. Each description includes general facts about the unit and gives the principal hazards and limitations to be considered in planning for specific uses.

Soils that have profiles that are almost alike make up a *soil series*. Except for differences in texture of the surface layer, all the soils of a series have major horizons that are similar in composition, thickness, and arrangement.

A soil series *family* has properties that are slightly outside the official series range but is in the same taxonomic classification as the official series. An example is Plumasano-Tanoan family-Gladel complex, 2 to 50 percent slopes.

Taxadjuncts are soils that have properties outside the range of any recognized series, and are given the name of an established series that is most similar in characteristics. Soils are recognized as taxadjuncts only when one or more of their characteristics are slightly outside the range defined for the family of the series for which the soils are named. The differences in properties are small so that major interpretations are not affected. An example is Rock outcrop-Nizhoni-Bamac complex, 5 to 60 percent slopes. Nizhoni is identified as a taxadjunct in table 4, Taxonomic Classification of the Soils.

Soils of one series can differ in texture of the surface layer, slope, stoniness, salinity, degree of erosion, and other characteristics that affect their use. On the basis of such differences, a soil series is divided into *soil phases*. Most of the areas shown on the detailed soil maps are phases of soil series. The name of a soil phase commonly indicates a feature that affects use or management. For example, Metuck very gravelly sandy loam, 25 to 65 percent slopes, is a phase of the Metuck series.

Some map units are made up of two or more major soils or miscellaneous areas. These map units are complexes.

A *complex* consists of two or more soils or miscellaneous areas in such an intricate pattern or in such small areas that they cannot be shown separately on the maps. The pattern and proportion of the soils or miscellaneous areas are somewhat similar in all areas. Nomrah-Plumasano-Gladel complex, 2 to 8 percent slopes, is an example.

Table 5 gives the acreage and proportionate extent of each map unit. Other tables give properties of the soils and the limitations, capabilities, and potentials for many uses. The Glossary defines many of the terms used in describing the soils or miscellaneous areas.

69—Nomrah-Plumasano-Gladel complex, 2 to 8 percent slopes

Map Unit Setting

General setting: broad, flat mesa tops of Natural Bridges National Monument (figs. 4 and 5)
Elevation: 5,800 to 6,700 feet (1,768 to 2,042 meters)
Mean annual precipitation: 12 to 15 inches (305 to 369 millimeters)
Mean annual air temperature: 46 to 50 degrees F (7.8 to 10.0 degrees C)
Mean annual soil temperature: 48 to 52 degrees F (8.9 to 11.1 degrees C)
Frost-free period: 130 to 160 days
Major Land Resource Area: 36 – Southwestern Plateaus, Mesas, and Foothills

Map Unit Composition

Nomrah and similar soils: 55 percent
Plumasano and similar soils: 25 percent
Gladel and similar soils: 15 percent
Minor components:
- Rock outcrop (Cedar Mesa Formation Sandstone)
- Shallow and moderately deep soils with petrocalcic horizons – Upland Shallow Loam (Pinyon/Utah Juniper)

Figure 4.—Landscape of map unit 69. Dominant vegetation is pinyon, Utah juniper, and Basin Big Sagebrush.

Figure 5.—Typical landscape of map unit 69. Dominant vegetation is pinyon, Utah juniper, and Basin Big Sagebrush.

Soil Properties and Qualities

Nomrah soils

Taxonomic classification: Fine-loamy, mixed, superactive, mesic Calcidic Haplustalfs (fig. 6)
Landform: Mesas
Geology: Cedar Mesa Formation Sandstone (Permian)
Parent material: eolian deposits derived from sandstone
Slope: 2 to 6 percent

Figure 6.—Profile of Nomrah soil within map unit 69. Calcic horizon is at 40 centimeters.

Ground Cover:	(% Cover)
Plant Canopy:	50-65
Litter <5mm:	7-15
Rock Fragments:	0-1
Bare Soil:	0-5
Cyanobacteria Crust:	25-35
Lichen Crust:	2-5
Moss Crust:	2-5
Salt Crust:	0
Gypsum Crust:	0

Depth to restrictive feature(s): greater than 60 inches
Drainage class: well drained
Slowest permeability: 0.6 to 2.0 in/hr (moderate)
Available water capacity total inches: about 9.0 (high)
Shrink-swell potential: about 1.5 LEP (low)
Flooding hazard: none
Ponding hazard: none
Seasonal water table minimum depth: greater than 60 inches
Runoff class: low
Hydrologic group: B
Calcium carbonate maximum: about 30 percent
Gypsum maximum: none
Salinity maximum: about 2 mmhos/cm (nonsaline)
Sodium adsorption ratio maximum: about 13 SAR (moderately sodic)
Ecological site name: Upland Loam (Big Sagebrush)
Ecological site number: R036XY306UT
Present vegetation (in most areas): basin big sagebrush, Utah juniper, Wright birdbeak, pinyon, lobeleaf groundsel
Land capability (non irrigated): 6e

Typical Profile

Location

Geographic Coordinate System (Universal Transverse Mercator): 589,340 meters E, 4162,467 meters N, zone 12.

A—0 to 2 inches (0 to 5 cm); strong brown (7.5YR 5/6) very fine sandy loam, reddish brown (5YR 4/4), moist; 11 percent clay; weak thick platy parting to moderate fine granular structure; soft, very friable, slightly sticky and nonplastic; many very fine and common fine roots throughout; many very fine and common fine interstitial pores; noneffervescent; moderately alkaline, pH 8.0; gradual smooth boundary.

Bt1—2 to 8 inches (5 to 20 cm); yellowish red (5YR 4/6) loam, reddish brown (5YR 4/4), moist; 23 percent clay; moderate medium subangular blocky structure; slightly hard, firm, slightly sticky and slightly plastic; many very fine, common fine, and few medium roots throughout; many very fine, common fine, and common medium tubular pores; few discontinuous distinct clay films on surfaces along pores and on all faces of peds; noneffervescent; moderately alkaline, pH 8.1; clear wavy boundary.

Bt2—8 to 13.5 inches (20 to 34 cm); yellowish red (5YR 4/6) loam, yellowish red (5YR 4/6), moist; 25 percent clay; moderate coarse subangular blocky parting to moderate medium subangular blocky structure; hard, very firm, moderately sticky and moderately plastic; common very fine, common fine, few medium, few coarse, and few very coarse roots throughout; many very fine, common fine, and common medium tubular pores; few discontinuous prominent clay films on all faces of peds and many continuous prominent clay films on surfaces along pores;

common coarse cylindrical insect casts in matrix; noneffervescent; moderately alkaline, pH 8.1; clear wavy boundary.

Btk1—13.5 to 19.5 inches (34 to 49 cm); reddish yellow (5YR 6/6) loam, yellowish red (5YR 4/6), moist; 25 percent clay; strong medium angular blocky structure; very hard, extremely firm, moderately sticky and moderately plastic; common very fine and fine, and few medium, coarse, and very coarse roots throughout; many very fine, and common fine, medium, and coarse tubular pores; few discontinuous distinct clay films on all faces of peds and common discontinuous distinct clay films on surfaces along pores; common fine threadlike carbonate masses and common coarse cylindrical insect casts in matrix; strongly effervescent; moderately alkaline, pH 8.1; clear wavy boundary.

Btk2—19.5 to 38.5 inches (49 to 98 cm); reddish yellow (5YR 7/6) fine sandy loam, yellowish red (5YR 5/6), moist; 18 percent clay; moderate medium angular blocky structure; very hard, extremely firm, moderately sticky and moderately plastic; few fine and medium roots throughout; many very fine and common fine tubular pores; few patchy faint clay films on all faces of peds; many coarse irregular carbonate masses in matrix; violently effervescent; moderately alkaline, pH 8.4; gradual wavy boundary.

Bkn1—38.5 to 48 inches (98 to 122 cm); pink (5YR 7/3) sandy loam, light reddish brown (5YR 6/4), moist; 17 percent clay; moderate medium subangular blocky and moderate fine subangular blocky structure; very hard, extremely firm, moderately sticky and slightly plastic; few fine roots; common very fine and common fine tubular pores; finely disseminated carbonate throughout; violently effervescent; strongly alkaline, pH 8.6; clear smooth boundary.

Bkn2—48 to 59 inches (122 to 150 cm); yellowish red (5YR 5/6) sandy clay loam, yellowish red (5YR 4/6), moist; 21 percent clay; moderate medium and moderate fine subangular blocky structure; very hard, extremely firm, moderately sticky and moderately plastic; few fine roots; common very fine and common fine tubular pores; many coarse irregular carbonate masses in matrix; strongly effervescent; strongly alkaline, pH 8.8; clear smooth boundary.

Bkn3—59 to 65.5 inches (150 to 166 cm); reddish yellow (5YR 6/6) loam, yellowish red (5YR 4/6), moist; 16 percent clay; moderate medium and moderate fine subangular blocky structure; very hard, extremely firm, slightly sticky and moderately plastic; few fine roots; common very fine and fine tubular pores; finely disseminated carbonate throughout; violently effervescent; strongly alkaline, pH 8.8; clear smooth boundary.

Bkn4—65.5 to 78.5 inches (166 to 200 cm); light reddish brown (5YR 6/4) loam, yellowish red (5YR 4/6), moist; 15 percent clay; moderate medium and moderate fine subangular blocky structure; hard, firm, slightly sticky and moderately plastic; finely disseminated carbonate throughout; violently effervescent; strongly alkaline, pH 8.8.

Range in Characteristics

A horizon
- Value: 4 or 5, dry or moist
- Chroma: 4 or 6 dry, 3 or 4 moist
- Texture: very fine sandy loam, loam, fine sandy loam
- Clay content: 7 to 18 percent
- Calcium carbonate equivalent: 0 to 5 percent
- Rock fragments: 0 to 5 percent gravel
- Reaction: slightly alkaline or moderately alkaline (pH 7.4 to 8.4)

Bt horizon
- Value: 4 or 5 dry, 3 or 4 moist

Chroma: 4 or 6, dry or moist
Texture: loam, very fine sandy loam, fine sandy loam
Clay content: 15 to 27 percent
Calcium carbonate equivalent: 0 to 5 percent
Rock fragments: 0 to 5 percent gravel

Btk horizon
Value: 5 to 7 dry, 4 or 5 moist
Chroma: 4 or 6, dry or moist
Texture: loam, very fine sandy loam, fine sandy loam, sandy loam
Clay content: 10 to 27 percent
Calcium carbonate equivalent: 15 to 30 percent
Rock fragments: 0 to 5 percent sandstone gravel
Reaction: moderately alkaline or strongly alkaline (pH 7.9 to 9.0)

Bkn or Bk horizon
Value: 5 to 7 dry, 4 to 6 moist
Chroma: 3 to 6 dry, 4 or 6 moist
Texture: sandy loam, loam, sandy clay loam, fine sandy loam
Clay content: 10 to 27 percent
Calcium carbonate equivalent: 15 to 30 percent
Rock fragments: 0 to 5 percent gravel
Reaction: moderately alkaline or strongly alkaline (pH 7.9 to 9.0)

This soil differs from the Nomrah series in that the depth to the base of the argillic horizon is between 30 and 40 inches, the soil reaction in the calcic horizon ranges to strongly alkaline, and depth to calcic horizon is 25 to 40 inches.

Plumasano soils
Taxonomic classification: Coarse-loamy, mixed, superactive, mesic Aridic Calciustepts
Landform: Mesas
Geology: Cedar Mesa Formation Sandstone (Permian)
Parent material: eolian deposits derived from sandstone
Slope: 2 to 6 percent

Ground Cover:	(% Cover)
Plant Canopy:	45-60
Litter <5mm:	5-10
Rock Fragments:	0-1
Bare Soil:	0-5
Cyanobacteria Crust:	20-30
Lichen Crust:	10-20
Moss Crust:	3-7
Salt Crust:	0
Gypsum Crust:	0

Depth to restrictive feature(s): greater than 60 inches
Drainage class: well drained
Slowest permeability: 2.0 to 6.0 in/hr (moderately rapid)
Available water capacity total inches: about 6.6 (moderate)
Shrink-swell potential: about 1.5 LEP (low)
Flooding hazard: none
Ponding hazard: none
Seasonal water table minimum depth: greater than 60 inches
Runoff class: very low
Hydrologic group: B

Calcium carbonate maximum: about 15 percent
Gypsum maximum: none
Salinity maximum: about 4 mmhos/cm (very slightly saline)
Sodium adsorption ratio maximum: about 8 SAR (slightly sodic)
Ecological site name: Upland Loam (Pinyon/Utah Juniper)
Ecological site number: R036XY307UT
Present vegetation (in most areas): Utah juniper, basin big sagebrush, Wright birdbeak, pinyon, lobeleaf groundsel
Land capability (non irrigated): 6e

Typical Profile

Location
Geographic Coordinate System (Universal Transverse Mercator): 591,025 meters E, 4162,893 meters N, zone 12.

Oi—0 to 0.5 inch (0 to 1 cm); slightly decomposed leaves and twigs.

A—0.5 inch to 2.5 inches (1 to 6 cm); brown (7.5YR 5/4) fine sandy loam, brown (7.5YR 4/3), moist; 10 percent clay; weak medium platy parting to weak medium granular structure; soft, very friable, slightly sticky and nonplastic; many very fine and common fine roots throughout; common very fine and fine interstitial pores; noneffervescent; moderately alkaline, pH 8.0; clear, wavy boundary.

BA—2.5 to 6 inches (6 to 15 cm); yellowish red (5YR 5/6) fine sandy loam, reddish brown (5YR 4/3), moist; 11 percent clay; moderate medium platy parting to weak medium subangular blocky and moderate thick platy structure; slightly hard, friable, slightly sticky and nonplastic; common very fine, many fine, common medium, and few coarse roots throughout; common very fine and few fine tubular pores; noneffervescent; moderately alkaline, pH 8.0; clear, wavy boundary.

Bk1—6 to 19.5 inches (15 to 50 cm); yellowish red (5YR 5/6) fine sandy loam, reddish brown (5YR 4/4), moist; 15 percent clay; moderate fine and medium subangular blocky structure; hard, firm, slightly sticky and slightly plastic; common very fine and fine, and few medium roots throughout; common very fine and fine, and few medium tubular pores; many coarse irregular carbonate masses in matrix; slightly effervescent; moderately alkaline, pH 8.2; clear, wavy boundary.

Bk2—19.5 to 55 inches (50 to 140 cm); yellowish red (5YR 5/6) fine sandy loam, reddish brown (5YR 4/4), moist; 13 percent clay; moderate medium and fine subangular blocky structure; hard, firm, slightly sticky and slightly plastic; few very fine and fine roots throughout; common very fine and fine tubular pores; many coarse irregular carbonate masses in matrix; strongly effervescent; moderately alkaline, pH 8.4; clear, wavy boundary.

C—55 to 72 inches (140 to 183 cm); yellowish red (5YR 5/6) fine sandy loam, reddish brown (5YR 4/4), moist; 8 percent clay; massive; slightly hard, friable, slightly sticky and nonplastic; few fine roots throughout; common very fine tubular pores; very slightly effervescent; moderately alkaline, pH 8.0.

Range in Characteristics

A horizon
Hue: 5YR, 7.5YR
Value: 4 or 5 dry, 3 or 4 moist
Chroma: 3 to 6, dry or moist
Texture: fine sandy loam, very fine sandy loam
Clay content: 6 to 12 percent
Calcium carbonate equivalent: 0 to 2 percent
Rock fragments: 0 to 5 percent gravel

Bw or BA horizon
- Value: 4 or 5 dry, 3 or 4 moist
- Chroma: 4 or 6 dry, 3 or 4 moist
- Texture: fine sandy loam, very fine sandy loam
- Clay content: 10 to 18 percent
- Calcium carbonate equivalent: 0 to 10 percent
- Rock fragments: 0 to 5 percent gravel

Bk horizons
- Value: 4 or 5, dry or moist
- Chroma: 4 or 6, dry or moist
- Texture: fine sandy loam, very fine sandy loam
- Clay content: 10 to 18 percent
- Rock fragments: 0 to 5 percent gravel
- Calcium carbonate equivalent: 10 to 15 percent
- Reaction: moderately alkaline or strongly alkaline (pH 7.9 to 9.0)

C horizon
- Value: 4 or 5, dry or moist
- Chroma: 4 or 6, dry or moist
- Texture: fine sandy loam, sandy loam, loamy fine sand
- Clay content: 7 to 14 percent
- Rock fragments: 0 to 10 percent channers
- Calcium carbonate equivalent: 5 to 15 percent
- Reaction: moderately alkaline or strongly alkaline (pH 7.9 to 9.0)

This soil is a taxadjunct to the Plumasano series because this soil consistently has more than 5 percent identifiable secondary carbonates in the subsoil and is calcareous in all parts above the calcic horizon when the surface soil is mixed to a depth of 18 cm.

Gladel soils

Taxonomic classification: Loamy, mixed, superactive, mesic Aridic Lithic Haplustepts (fig. 7)
Landform: Mesas
Geology: Cedar Mesa Formation Sandstone (Permian)
Parent material: eolian deposits derived from sandstone
Slope: 5 to 8 percent

Ground Cover:	(% Cover)
Plant Canopy:	30-50
Litter <5mm:	3-10
Rock Fragments:	0-1
Bare Soil:	0-5
Cyanobacteria Crust:	45-55
Lichen Crust:	7-15
Moss Crust:	2-8
Salt Crust:	0
Gypsum Crust:	0

Depth to restrictive feature(s): 9 to 20 inches to bedrock, lithic
Drainage class: well drained
Slowest permeability: 2.0 to 6.0 in/hr (moderately rapid)
Available water capacity total inches: about 1.7 (very low)
Shrink-swell potential: about 1.5 LEP (low)
Flooding hazard: none
Ponding hazard: none
Seasonal water table minimum depth: greater than 60 inches

Figure 7.—Gladel soil within map unit 69. Lithic contact is at 32 centimeters.

Runoff class: medium
Hydrologic group: D
Calcium carbonate maximum: about 15 percent
Gypsum maximum: None
Salinity maximum: about 2 mmhos/cm (nonsaline)
Sodium adsorption ratio maximum: about 0 SAR (nonsodic)
Ecological site name: Upland Shallow Loam (Pinyon/Utah Juniper)
Ecological site number: R036XY315UT
Present vegetation (in most areas): Utah juniper, pinyon, basin big sagebrush, Mormon tea, lobeleaf groundsel
Land capability (non irrigated): 7s

Typical Profile

Location

Geographic Coordinate System (Universal Transverse Mercator): 587,070 meters E, 4159,615 meters N, zone 12.

A—0 to 1.5 inch (0 to 4 cm); reddish brown (5YR 5/4) fine sandy loam, reddish brown (5YR 4/3), moist; 8 percent clay; weak thick platy structure; soft, very friable, nonsticky and nonplastic; many very fine and fine roots throughout; many very fine irregular pores; common fine irregular carbonate masses in matrix; slightly effervescent; moderately alkaline, pH 8.2; clear wavy boundary.

AB—1.5 inch to 8 inches (4 to 20 cm); reddish brown (5YR 5/4) fine sandy loam, reddish brown (5YR 4/4), moist; 8 percent clay; weak very thick platy structure; soft, very friable, nonsticky and nonplastic; many very fine and fine roots throughout; many very fine and fine, and common medium tubular pores; 5

percent gravel; slightly effervescent; moderately alkaline, pH 8.2; clear wavy boundary.

Bk—8 to 15.5 inches (20 to 40 cm); brown (7.5YR 5/4) fine sandy loam, brown (7.5YR 4/3), moist; 10 percent clay; weak medium and fine subangular blocky structure; hard, firm, slightly sticky and nonplastic; many fine and medium roots throughout; many very fine and fine, and common medium tubular pores; common fine irregular carbonate masses in matrix; 5 percent gravel; strongly effervescent; moderately alkaline, pH 8.4; abrupt smooth boundary.

2R—15.5 to 25.5 inches (40 to 65 cm); many fine and medium roots in mat at top of horizon; hard Cedar Mesa Formation sandstone bedrock.

Range in Characteristics

A horizon
Value: 4 or 5 dry, 3 or 4 moist
Chroma: 4 to 6 dry, 3 or 4 moist
Clay content: 5 to 18 percent
Rock fragments: 0 to 5 percent gravel
Calcium carbonate equivalent: 0 to 5 percent

AB horizon
Hue: 5YR, 7.5YR
Value: 4 or 5 dry, 3 to 5 moist
Chroma: 4 to 6 dry, 3 or 4 moist
Texture: fine sandy loam, sandy loam
Clay content: 5 to 18 percent
Rock fragments: 0 to 15 percent gravel
Calcium carbonate equivalent: 0 to 10 percent

Bk horizon
Hue: 5YR, 7.5YR
Value: 4 to 6 dry, 3 to 5 moist
Chroma: 3 or 4, dry or moist
Texture: fine sandy loam, sandy loam
Clay content: 5 to 18 percent clay
Rock fragments: 5 to 35 percent gravel or channers
Calcium carbonate equivalent: 5 to 15 percent

70—Plumasano-Tanoan family-Gladel complex, 2 to 50 percent slopes

Map Unit Setting

General setting: Gently rolling mesas in Natural Bridges National Monument (fig. 8)
Elevation: 5,800 to 6,700 feet (1,768 to 2,042 meters)
Mean annual precipitation: 12 to 15 inches (305 to 369 millimeters)
Mean annual air temperature: 46 to 50 degrees F (7.8 to 10.0 degrees C)
Mean annual soil temperature: 48 to 52 degrees F (8.9 to 11.1 degrees C)
Frost-free period: 130 to 160 days
Major Land Resource Area: 36 – Southwestern Plateaus, Mesas, and Foothills

Map Unit Composition

Plumasano and similar soils: 50 percent
Tanoan family and similar soils: 20 percent

Gladel and similar soils: 15 percent
Minor components:
- Rock outcrop (Cedar Mesa Formation Sandstone)
- Nomrah soils on mesas – Upland Loam (Basin Big Sagebrush)

Soil Properties and Qualities

Plumasano soils
Taxonomic classification: Coarse-loamy, mixed, superactive, mesic Aridic Calciustepts (fig. 9)
Landform: Mesas
Geology: Cedar Mesa Formation Sandstone (Permian)
Parent material: eolian deposits derived from sandstone
Slope: 5 to 15 percent

Ground Cover:	(% Cover)
Plant Canopy:	45-60
Litter: <5mm:	5-10
Rock Fragments:	0-1
Bare Soil:	0-5
Cyanobacteria Crust:	20-30
Lichen Crust:	10-20
Moss Crust:	3-7
Salt Crust:	0
Gypsum Crust:	0

Depth to restrictive feature(s): 60 to 80 inches to bedrock, lithic
Drainage class: well drained

Figure 8. — Landscape of map unit 70. Dominant vegetation is pinyon, Utah juniper, and roundleaf buffaloberry.

Figure 9.— Profile of Plumasano soil in map unit 70. Scale is in centimeters.

Slowest permeability: 2.0 to 6.0 in/hr (moderately rapid)
Available water capacity total inches: about 6.6 (moderate)
Shrink-swell potential: about 1.5 LEP (low)
Flooding hazard: none
Ponding hazard: none
Seasonal water table minimum depth: greater than 60 inches
Runoff class: low
Hydrologic group: C
Calcium carbonate maximum: about 15 percent
Gypsum maximum: none
Salinity maximum: about 4 mmhos/cm (very slightly saline)
Sodium adsorption ratio maximum: about 8 SAR (slightly sodic)
Ecological site name: Upland Loam (Pinyon/Utah Juniper)
Ecological site number: R036XY307UT
Present vegetation (in most areas): Utah juniper, basin big sagebrush, Wright birdbeak, pinyon, lobeleaf groundsel
Land capability (non irrigated): 6e

Typical Profile

Location

Geographic Coordinate System (Universal Transverse Mercator): 587,230 meters E, 4160,515 meters N, zone 12.

A—0 to 2 inches (0 to 5 cm); yellowish red (5YR 4/6) loamy fine sand, dark reddish brown (5YR 3/4), moist; 11 percent clay; moderate medium granular and moderate fine subangular blocky structure; soft, very friable, slightly sticky and

nonplastic; many very fine and common fine roots throughout; common very fine and fine interstitial pores; very slightly effervescent; moderately alkaline, pH 8.2; very abrupt wavy boundary.

Bw—2 to 15 inches (5 to 38 cm); yellowish red (5YR 4/6) very fine sandy loam, dark reddish brown (5YR 3/4), moist; 12 percent clay; weak fine and moderate medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; common very fine, many fine, common medium, few coarse and very coarse roots throughout; common very fine and fine tubular pores; slightly effervescent; moderately alkaline, pH 8.3; gradual wavy boundary.

Bk1—15 to 18.5 inches (38 to 47 cm); yellowish red (5YR 5/6) very fine sandy loam, yellowish red (5YR 4/6), moist; 14 percent clay; moderate coarse subangular blocky structure; moderately hard, firm, slightly sticky and slightly plastic; common very and fine, and few medium roots throughout; many fine and few medium tubular pores; common medium irregular carbonate masses in matrix; strongly effervescent; moderately alkaline, pH 8.4; clear smooth boundary.

Bk2—18.5 to 34.5 inches (47 to 88 cm); yellowish red (5YR 5/6) very fine sandy loam, yellowish red (5YR 4/6), moist; 13 percent clay; moderate fine and medium subangular blocky structure; hard, firm, slightly sticky and nonplastic; few very fine and few fine roots throughout; few very fine and common fine tubular pores; common medium irregular carbonate masses in matrix and many carbonate coatings on vertical faces of peds; strongly effervescent; moderately alkaline, pH 8.4; clear smooth boundary.

Bk3—34.5 to 55.5 inches (88 to 141 cm); yellowish red (5YR 5/6) fine sandy loam, yellowish red (5YR 4/6), moist; 10 percent clay; weak fine subangular blocky structure; slightly hard, friable, slightly sticky and nonplastic; few fine roots throughout; few very fine and common fine tubular pores; violently effervescent; moderately alkaline, pH 8.4; clear smooth boundary.

C—55.5 to 65.5 inches (141 to 167 cm); yellowish red (5YR 5/6) loamy fine sand, yellowish red (5YR 4/6), moist; 8 percent clay; single grain; loose, slightly sticky and nonplastic; few fine roots throughout; few very fine and few fine interstitial pores; strongly effervescent; moderately alkaline, pH 8.4; abrupt smooth boundary.

2R—65.5 to 75.5 inches (167 to 192 cm); hard Cedar Mesa Formation sandstone bedrock.

Range in Characteristics

A horizon
- Hue: 5YR, 7.5YR
- Value: 4 or 5 dry, 3 or 4 moist
- Chroma: 4 to 6, dry or moist
- Texture: loamy fine sand, very fine sandy loam, fine sandy loam
- Clay content: 6 to 12 percent
- Calcium carbonate equivalent: 0 to 2 percent
- Rock fragments: 0 to 5 percent gravel

Bw horizon
- Value: 4 or 5 dry, 3 or 4 moist
- Chroma: 4 or 6 dry, 3 or 4 moist
- Texture: very fine sandy loam, fine sandy loam
- Clay content: 10 to 18 percent
- Calcium carbonate equivalent: 0 to 10 percent
- Rock fragments: 0 to 5 percent gravel

Bk horizons
- Value: 4 or 5, dry or moist
- Chroma: 4 or 6, dry or moist
- Texture: very fine sandy loam, fine sandy loam
- Clay content: 10 to 18 percent
- Rock fragments: 0 to 5 percent gravel
- Calcium carbonate equivalent: 5 to 15 percent
- Reaction: moderately alkaline or strongly alkaline (pH 7.9 to 9.0)

C horizon
- Value: 4 or 5, dry or moist
- Chroma: 4 or 6, dry or moist
- Texture: loamy fine sand, sandy loam
- Clay content: 7 to 14 percent
- Rock fragments: 0 to 10 percent channers
- Calcium carbonate equivalent: 5 to 15 percent
- Reaction: moderately alkaline or strongly alkaline (pH 7.9 to 9.0)

This soil is a taxadjunct to the Plumasano series because this soil consistently has more than 5 percent identifiable secondary carbonates in the subsoil and is calcareous in all parts above the calcic horizon when the surface soil is mixed to a depth of 18 cm.

Tanoan family soils
Taxonomic classification: Coarse-loamy, mixed, superactive, mesic Aridic Calciustepts
Landform: Breaks
Geology: Cedar Mesa Formation Sandstone (Permian)
Parent material: eolian deposits derived from sandstone
Slope: 20 to 50 percent

Ground Cover:	(% Cover)
Plant Canopy:	15-25
Litter <5mm:	1-5
Rock Fragments:	10-25
Bare Soil:	0-5
Cyanobacteria Crust:	40-60
Lichen Crust:	5-10
Moss Crust:	1-5
Salt Crust:	0
Gypsum Crust:	0

Depth to restrictive feature(s): 20 to 60 inches to bedrock, lithic
Drainage class: well drained
Slowest permeability: 0.6 to 2.0 in/hr (moderate)
Available water capacity total inches: about 3.4 (low)
Shrink-swell potential: about 1.5 LEP (low)
Flooding hazard: none
Ponding hazard: none
Seasonal water table minimum depth: greater than 60 inches
Runoff class: high
Hydrologic group: C
Calcium carbonate maximum: about 50 percent
Gypsum maximum: none

Salinity maximum: about 2 mmhos/cm (nonsaline)
Sodium adsorption ratio maximum: about 8 SAR (slightly sodic)
Ecological site name: Upland Dissected Slope (Pinyon/Utah Juniper)
Ecological site number: R036XY302UT
Present vegetation (in most areas): Utah juniper, pinyon, roundleaf buffaloberry, Mormon tea, Wright birdbeak
Land capability (non irrigated): 6e

Typical Profile

Location
Geographic Coordinate System (Universal Transverse Mercator): 588,390 meters E, 4161,511 meters N, zone 12.

Bk1—0 to 2 inches (0 to 5 cm); pink (5YR 7/4) gravelly loam, light reddish brown (5YR 6/4), moist; 22 percent clay; weak thick platy parting to weak very fine granular structure; soft, very friable, slightly sticky and nonplastic; common very fine, fine, and medium roots throughout; common very fine and fine irregular pores; finely disseminated carbonate throughout; 30 percent gravel; strongly effervescent; moderately alkaline, pH 8.4; abrupt smooth boundary.

Bk2—2 to 12 inches (5 to 30 cm); light reddish brown (5YR 6/6) fine sandy loam, reddish brown (5YR 5/4), moist; 17 percent clay; moderate medium and fine angular blocky structure; moderately hard, firm, slightly sticky and nonplastic; common fine roots throughout; common very fine and fine tubular pores; common discontinuous distinct carbonate coats on all faces of peds; finely disseminated carbonate throughout; strongly effervescent; strongly alkaline, pH 8.8; clear smooth boundary.

Bk3—12 to 25.5 inches (30 to 65 cm); light reddish brown (5YR 6/4) fine sandy loam, reddish brown (5YR 5/4), moist; 16 percent clay; weak medium and fine angular blocky structure; moderately hard, firm, slightly sticky and nonplastic; common fine roots throughout; common very fine and fine tubular pores; common fine threadlike carbonate masses in matrix; strongly effervescent; strongly alkaline, pH 8.8; clear smooth boundary.

C—25.5 to 34.5 inches (65 to 88 cm); reddish brown (5YR 5/4) sandy loam, reddish brown (5YR 4/4), moist; 8 percent clay; massive; soft, very friable, nonsticky and nonplastic; common fine roots throughout; common very fine irregular pores; 10 percent gravel; slightly effervescent; strongly alkaline, pH 8.8; clear smooth boundary.

2R—34.5 to 44.5 inches (88 to 113 cm); hard Cedar Mesa Formation sandstone bedrock.

Range in Characteristics

A horizon (where present)
Value: 4 or 5, dry or moist
Chroma: 3 or 4, dry or moist
Texture: fine sandy loam, very fine sandy loam
Clay content: 8 to 15 percent
Rock fragments: 0 to 10 percent gravel

Bk or Bkm horizon
Value: 4 to 7, dry or moist
Chroma: 4 to 6, dry or moist
Texture: fine sandy loam, loam, sandy loam
Clay content: 10 to 27 percent
Calcium carbonate equivalent: 15 to 50 percent
Rock fragments: 0 to 30 percent gravel

C horizon
- Value: 4 to 7 dry, 4 or 5 moist
- Chroma: 4 to 6, dry or moist
- Texture: sandy loam, fine sandy loam
- Clay content: 5 to 18 percent
- Calcium carbonate equivalent: 10 to 50 percent
- Rock fragments: 0 to 15 percent gravel

Gladel soils

Taxonomic classification: Loamy, mixed, superactive, mesic Aridic Lithic Haplustepts
Landform: Mesas
Geology: Cedar Mesa Formation Sandstone (Permian)
Parent material: eolian deposits derived from sandstone
Slope: 2 to 8 percent

Ground Cover:	(% Cover)
Plant Canopy:	30-50
Litter <5mm:	3-10
Rock Fragments:	0-1
Bare Soil:	0-5
Cyanobacteria Crust:	45-55
Lichen Crust:	7-15
Moss Crust:	2-8
Salt Crust:	0
Gypsum Crust:	0

Depth to restrictive feature(s): 9 to 20 inches to bedrock, lithic
Drainage class: well drained
Slowest permeability: 2.0 to 6.0 in/hr (moderately rapid)
Available water capacity total inches: about 1.5 (very low)
Shrink-swell potential: about 1.5 LEP (low)
Flooding hazard: none
Ponding hazard: none
Seasonal water table minimum depth: greater than 60 inches
Runoff class: medium
Hydrologic group: D
Calcium carbonate maximum: about 15 percent
Gypsum maximum: none
Salinity maximum: about 2 mmhos/cm (nonsaline)
Sodium adsorption ratio maximum: about 0 SAR (nonsodic)
Ecological site name: Upland Shallow Loam (Pinyon/Utah Juniper)
Ecological site number: R036XY315UT
Present vegetation (in most areas): Utah juniper, pinyon, basin big sagebrush, Mormon tea, lobeleaf groundsel
Land capability (non irrigated): 7s

Typical Profile

Location

Geographic Coordinate System (Universal Transverse Mercator): 587,159 meters E, 4159,073 meters N, zone 12.

A—0 to 3 inches (0 to 7 cm); yellowish red (5YR 5/6) fine sandy loam, dark reddish brown (5YR 3/4), moist; 10 percent clay; weak fine granular structure; soft, very friable, nonsticky and nonplastic; common very fine, many fine, and few medium roots throughout; many very fine irregular pores; very slightly effervescent; slightly alkaline, pH 7.8; clear smooth boundary.

Bw—3 to 7 inches (7 to 18 cm); yellowish red (5YR 5/6) fine sandy loam, reddish

brown (5YR 5/4), moist; 10 percent clay; weak medium subangular blocky structure; soft, very friable, nonsticky and nonplastic; few very fine, common fine, and few medium roots throughout; many very fine, and common fine and medium tubular pores; slightly effervescent; moderately alkaline, pH 8.0; clear wavy boundary.

Bk1—7 to 11 inches (18 to 28 cm); reddish brown (5YR 4/4) gravelly fine sandy loam, dark reddish brown (5YR 3/4), moist; 12 percent clay; weak fine subangular blocky structure; slightly hard, friable, slightly sticky and nonplastic; few very fine, and common fine and medium roots; common very fine and fine, and few medium tubular pores; few carbonate coats on rock fragments; 15 percent gravel; strongly effervescent; moderately alkaline, pH 8.2; abrupt irregular boundary.

Bk2—11 to 13.5 inches (28 to 34 cm); reddish brown (5YR 4/4) gravelly fine sandy loam, dark reddish brown (5YR 3/4), moist; 12 percent clay; weak fine subangular blocky structure; soft, very friable, slightly sticky and nonplastic; few fine roots; common very fine and fine tubular pores; few carbonate coats on rock fragments; 20 percent gravel, 5 percent channers, and 5 percent flagstones; strongly effervescent; moderately alkaline, pH 8.2; abrupt irregular boundary.

2R—13.5 to 23 inches (34 to 59 cm); hard Cedar Mesa Formation sandstone bedrock.

Range in Characteristics

A horizon
Value: 4 or 5 dry, 3 or 4 moist
Chroma: 4 to 6 dry, 3 or 4 moist
Clay content: 5 to 18 percent
Rock fragments: 0 to 5 percent gravel
Calcium carbonate equivalent: 0 to 5 percent

Bw, BA, or AB horizon
Hue: 5YR, 7.5YR
Value: 4 or 5 dry, 3 to 5 moist
Chroma: 4 to 6 dry, 3 or 4 moist
Texture: fine sandy loam, sandy loam
Clay content: 5 to 18 percent
Rock fragments: 0 to 15 percent gravel
Calcium carbonate equivalent: 0 to 5 percent

Bk horizon
Hue: 5YR, 7.5YR
Value: 4 to 6 dry, 3 to 5 moist
Chroma: 3 or 4, dry or moist
Clay content: 5 to 18 percent clay
Rock fragments: 5 to 40 percent gravel, channers, or flagstones
Calcium carbonate equivalent: 10 to 15 percent

71—Gladel-Rock outcrop complex, 5 to 15 percent slopes

Map Unit Setting

General setting: Structural benches and mesas in Natural Bridges National Monument (figs. 10 and 11)
Elevation: 5,800 to 6,700 feet (1,768 to 2,042 meters)
Mean annual precipitation: 12 to 15 inches (305 to 369 millimeters)
Mean annual air temperature: 46 to 50 degrees F (7.8 to 10.0 degrees C)

Figure 10.— Landscape of map unit 71. Dominant vegetation is pinyon, Utah juniper, cliffrose, and green Mormon tea.

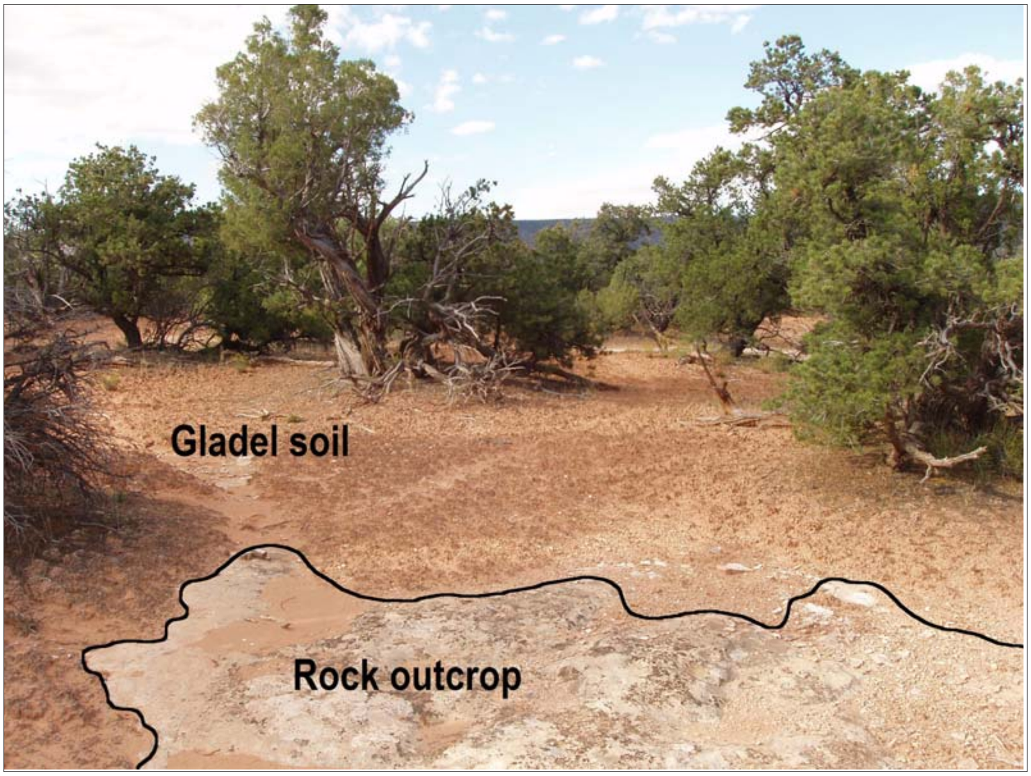

Figure 11.— Landscape of map unit 71.

Mean annual soil temperature: 48 to 52 degrees F (8.9 to 11.1 degrees C)
Frost-free period: 130 to 160 days
Major Land Resource Area: 36 – Southwestern Plateaus, Mesas, and Foothills

Map Unit Composition

Gladel and similar soils: 70 percent
Rock outcrop, Cedar Mesa Formation Sandstone: 20 percent
Minor components:
- Nizhoni soils on mesas and structural benches – Upland Shallow Loam (Littleleaf Mountain Mahogany)

Soil Properties and Qualities

Gladel soils
Taxonomic classification: Loamy, mixed, superactive, mesic Aridic Lithic Haplustepts (fig. 12)
Landform: Structural benches, mesas
Geology: Cedar Mesa Formation Sandstone (Permian)
Parent material: eolian deposits derived from sandstone
Slope: 5 to 15 percent

Ground Cover:	(% Cover)
Plant Canopy:	25-45
Litter <5mm:	3-10
Rock Fragments:	0-1
Bare Soil:	0-5
Cyanobacteria Crust:	40-55
Lichen Crust:	10-25
Moss Crust:	5-10
Salt Crust:	0
Gypsum Crust:	0

Depth to restrictive feature(s): 9 to 20 inches to bedrock, lithic
Drainage class: well drained
Slowest permeability: 2.0 to 6.0 in/hr (moderately rapid)
Available water capacity total inches: about 1.0 (very low)
Shrink-swell potential: about 1.5 LEP (low)
Flooding hazard: none
Ponding hazard: none
Seasonal water table minimum depth: greater than 60 inches
Runoff class: medium
Hydrologic group: D
Calcium carbonate maximum: about 15 percent
Gypsum maximum: None
Salinity maximum: about 2 mmhos/cm (nonsaline)
Sodium adsorption ratio maximum: about 0 SAR (nonsodic)
Ecological site name: Upland Shallow Loam (Pinyon/Utah Juniper)
Ecological site number: R036XY315UT
Present vegetation (in most areas): Utah juniper, pinyon, broom snakeweed, Mormon tea, lobeleaf groundsel
Land capability (non irrigated): 7s

Typical Profile

Location
Geographic Coordinate System (Universal Transverse Mercator): 587,648 meters E, 4162,921 meters N, zone 12.

Figure 12.— Profile of Gladel soil in map unit 71. Lithic contact is at 43 centimeters.

Oi—0 to 1 inch (0 to 3 cm) slightly decomposed plant material.

A—1 inch to 4.5 inches (3 to 12 cm); reddish brown (5YR 5/4) fine sandy loam, dark reddish brown (5YR 3/4), moist; 12 percent clay; weak medium subangular blocky parting to weak fine granular structure; soft, very friable, slightly sticky and nonplastic; common very fine and fine, and few medium roots throughout; common very fine and fine tubular pores; strongly effervescent; slightly alkaline, pH 7.8; clear smooth boundary.

Bk1—4.5 to 7.5 inches (12 to 19 cm); brown (7.5YR 4/3) fine sandy loam, dark brown (7.5YR 3/2), moist; 16 percent clay; weak fine granular and moderate fine subangular blocky structure; soft, very friable, slightly sticky and nonplastic; common very fine, fine, and medium roots throughout; common very fine, fine, and medium tubular pores; common fine threadlike and many coarse irregular carbonate masses in matrix; 5 percent gravel; strongly effervescent; moderately alkaline, pH 8.2; clear smooth boundary.

Bk2—7.5 to 10 inches (19 to 26 cm); light reddish brown (5YR 6/4) weakly cemented sandy loam, reddish brown (5YR 5/4), moist; 12 percent clay; moderate coarse and medium subangular blocky structure; extremely hard, slightly rigid, slightly sticky and nonplastic; few fine roots along ped faces; many fine tubular pores; finely disseminated carbonate throughout; 10 percent gravel; violently effervescent; moderately alkaline, pH 8.3; clear smooth boundary.

2R—10 to 20 inches (26 to 51 cm); common medium and coarse roots in mat at top of horizon; hard Cedar Mesa Formation sandstone bedrock.

Range in Characteristics

A horizon
- Value: 4 or 5 dry, 3 or 4 moist
- Chroma: 4 to 6 dry, 3 or 4 moist
- Clay content: 5 to 18 percent
- Rock fragments: 0 to 5 percent gravel
- Calcium carbonate equivalent: 0 to 5 percent

Bk1 horizon
- Hue: 5YR, 7.5YR
- Value: 4 or 5 dry, 3 to 5 moist
- Chroma: 3 to 6 dry, 2 to 4 moist
- Texture: sandy loam, fine sandy loam
- Clay content: 5 to 18 percent
- Rock fragments: 0 to 15 percent gravel
- Calcium carbonate equivalent: 5 to 15 percent

Bk2 horizon:
- Hue: 5YR, 7.5YR
- Value: 4 to 6 dry, 3 to 5 moist
- Chroma: 3 or 4, dry or moist
- Texture: sandy loam, fine sandy loam
- Clay content: 5 to 18 percent clay
- Rock fragments: 5 to 40 percent gravel or channers
- Calcium carbonate equivalent: 5 to 15 percent

Rock outcrop, Cedar Mesa Formation Sandstone
This component is characterized by gently sloping expanses of sandstone with short escarpments at the edges of the rock strata. Vertical relief is rarely more than a few feet.

72—Rock outcrop-Nizhoni-Bamac complex, 5 to 60 percent slopes

Map Unit Setting

General setting: Canyon sides and canyon rims in Natural Bridges National Monument (fig. 13)
Elevation: 5,600 to 6,600 feet (1,707 to 2,012 meters)
Mean annual precipitation: 12 to 15 inches (305 to 369 millimeters)
Mean annual air temperature: 46 to 50 degrees F (7.8 to 10.0 degrees C)
Mean annual soil temperature: 48 to 52 degrees F (8.9 to 11.1 degrees C)
Frost-free period: 130 to 160 days
Major Land Resource Area: 36 – Southwestern Plateaus, Mesas, and Foothills

Map Unit Composition

Rock outcrop, Cedar Mesa Formation Sandstone: 60 percent
Nizhoni and similar soils: 15 percent
Bamac and similar soils: 15 percent
Minor components:
- Shallow soils with more surface fragments and higher slopes – Upland Shallow Loam (Littleleaf Mountain Mahogany)
- Gladel soils on ledges and structural benches – Upland Shallow Loam (Pinyon/Utah Juniper)

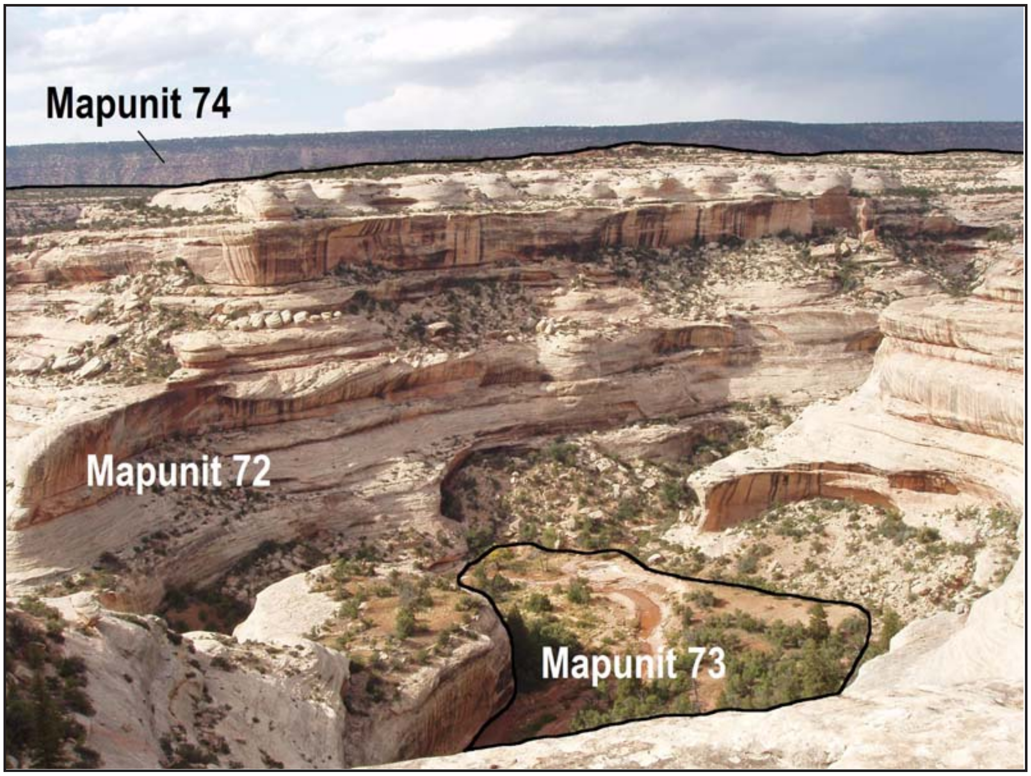

Figure 13.— Landscape positions of map unit 72, 73, and 74.

Soil Properties and Qualities

Rock outcrop, Cedar Mesa Formation Sandstone

This component varies from gently sloping expanses of exposed sandstone with short escarpments at the edges of the rock strata to nearly vertical canyon walls. Vertical relief varies from a few feet to about 500 feet.

Nizhoni soils

Taxonomic classification: Loamy, mixed, superactive, calcareous, mesic Aridic Lithic Ustorthents (fig. 14)
Landform: Ledges, structural benches (fig. 15)
Geology: Cedar Mesa Formation Sandstone (Permian)
Parent material: eolian deposits derived from sandstone
Slope: 5 to 15 percent

Ground Cover:	(% Cover)
Plant Canopy:	30-60
Litter <5mm:	3-10
Rock Fragments:	0-5
Bare Soil:	0-5
Cyanobacteria Crust:	20-50
Lichen Crust:	10-30
Moss Crust:	5-10
Salt Crust:	0
Gypsum Crust:	0

Depth to restrictive feature(s): 4 to 20 inches to bedrock, lithic
Drainage class: well drained
Slowest permeability: 2.0 to 6.0 in/hr (moderately rapid)
Available water capacity total inches: about 1.1 (very low)

Shrink-swell potential: about 1.5 LEP (low)
Flooding hazard: none
Ponding hazard: none
Seasonal water table minimum depth: greater than 60 inches
Runoff class: medium
Hydrologic group: D
Calcium carbonate maximum: about 15 percent
Gypsum maximum: none
Salinity maximum: about 1 mmhos/cm (nonsaline)
Sodium adsorption ratio maximum: about 0 SAR (nonsodic)
Ecological site name: Upland Shallow Loam (Littleleaf Mountain Mahogany)
Ecological site number: R036XY316UT
Present vegetation (in most areas): Utah juniper, pinyon, Indian ricegrass, littleleaf mountain mahogany, Utah serviceberry
Land capability (non irrigated): 7s

Typical Profile

Location

Geographic Coordinate System (Universal Transverse Mercator): 587,213 meters E, 4159,514 meters N, zone 12.

A—0 to 3 inches (0 to 7 cm); yellowish red (5YR 5/6) loamy fine sand, reddish brown (5YR 4/3), moist; 6 percent clay; moderate medium granular and moderate medium subangular blocky structure; soft, very friable, slightly sticky and nonplastic; many very fine and common fine roots throughout; many very fine interstitial and common fine tubular pores; slightly effervescent; moderately alkaline, pH 8.0; abrupt wavy boundary.

Figure 14.— Profile of Nizhoni soil in map unit 72. Lithic contact is at 22 centimeters.

Figure 15.— Landscape of map unit 72 showing a typical location of the Nizhoni soil on canyon ledges (in foreground). Dominant vegetation is pinyon, Utah juniper, and green Mormon tea.

C—3 to 8.5 inches (7 to 21 cm); reddish brown (5YR 5/4) very fine sandy loam, reddish brown (5YR 4/4), moist; 10 percent clay; massive; soft, very friable, slightly sticky and nonplastic; many very fine, and common fine and medium roots throughout; many very fine interstitial and common fine and medium tubular pores; 5 percent fine gravel; strongly effervescent; moderately alkaline, pH 8.2; abrupt wavy boundary.

2R—8.5 to 18 inches (21 to 46 cm); common fine and medium roots in cracks; hard Cedar Mesa Formation sandstone bedrock.

Range in Characteristics

A horizon
Hue: 5YR, 7.5YR
Value: 3 to 5 dry, 4 or 5 moist
Chroma: 4 to 6, dry or moist
Texture: loamy fine sand, fine sandy loam
Clay content: 5 to 12 percent
Rock fragments: 0 to 5 percent gravel
Calcium carbonate equivalent: 0 to 5 percent
Reaction: slightly alkaline or moderately alkaline (pH 7.4 to 8.4)

C horizon
Hue: 5YR, 7.5YR
Value: 4 to 7 dry, 4 to 6 moist
Chroma: 3 to 6, dry or moist
Texture: very fine sandy loam, fine sandy loam, sandy loam
Clay content: 7 to 14 percent

Figure 16.— Profile of Bamac soil. Scale is in centimeters.

Rock fragments: 0 to 20 percent channers
Calcium carbonate equivalent: 5 to 15 percent
Reaction: moderately alkaline or strongly alkaline (pH 7.9 to 8.4)

Some pedons have thin horizons directly above the bedrock with up to 50 percent parachanners.

This soil is a taxadjunct to the Nizhoni series because the cation-exchange activity class is inferred to be superactive.

Bamac soils
Taxonomic classification: Sandy-skeletal, mixed, mesic Aridic Ustorthents (fig. 16)
Landform: Talus slopes, escarpments (fig. 17)
Geology: Cedar Mesa Formation Sandstone (Permian)
Parent material: colluvium derived from sandstone
Slope: 20 to 60 percent

Ground Cover:	(% Cover)
Plant Canopy:	20-50
Litter <5mm:	0-5
Rock Fragments:	30-50
Bare Soil:	0-5
Cyanobacteria Crust:	0-5
Lichen Crust:	0-3
Moss Crust:	0-3
Salt Crust:	0
Gypsum Crust:	0

Depth to restrictive feature(s): greater than 60 inches to bedrock
Drainage class: excessively drained
Slowest permeability: 6.0 to 20 in/hr (rapid)
Available water capacity total inches: about 1.8 (very low)
Shrink-swell potential: about 1.5 LEP (low)
Flooding hazard: none
Ponding hazard: none
Seasonal water table minimum depth: greater than 60 inches
Runoff class: low
Hydrologic group: A
Calcium carbonate maximum: about 5 percent
Gypsum maximum: none
Salinity maximum: about 1 mmhos/cm (nonsaline)
Sodium adsorption ratio maximum: about 0 SAR (nonsodic)
Ecological site name: Upland Very Steep Stony Loam (Pinyon/Utah Juniper)
Ecological site number: R036XY328UT
Present vegetation (in most areas): Salina wildrye, pinyon, Utah juniper, Utah serviceberry, roundleaf buffaloberry
Land capability (non irrigated): 7s

Typical Profile

Location

Geographic Coordinate System (Universal Transverse Mercator): 587,172 meters E, 4163,439 meters N, zone 12.

A—0 to 4.5 inches (0 to 11 cm); light brown (7.5YR 6/3) gravelly loamy fine sand, brown (7.5YR 5/4), moist; 6 percent clay; weak fine subangular blocky and weak medium granular structure; soft, very friable, nonsticky and nonplastic; common

Figure 17.— Landscape of map unit 72 showing typical position of Bamac soil on talus slopes. Vegetation includes pinyon and Utah juniper.

very fine and fine roots throughout; many very fine and common fine interstitial pores; 20 percent fine gravel; strongly effervescent; moderately alkaline, pH 8.2; abrupt broken boundary.

C1—4.5 to 21.5 inches (11 to 55 cm); very pale brown (10YR 7/4) very gravelly sand, light yellowish brown (10YR 6/4), moist; 2 percent clay; massive; soft, very friable, nonsticky and nonplastic; common very fine, fine, and medium roots throughout; many very fine and common fine interstitial pores; 50 percent gravel and 15 percent cobbles; strongly effervescent; moderately alkaline, pH 8.4; gradual wavy boundary.

C2—21.5 to 60 inches (55 to 153 cm); pale yellow (2.5Y 8/3) very gravelly sand, light yellowish brown (2.5Y 6/4), moist; 1 percent clay; single grain; loose, nonsticky and nonplastic; common very fine and fine roots throughout; many very fine and common fine interstitial pores; 40 percent gravel and 30 percent cobbles; strongly effervescent; moderately alkaline, pH 8.4; abrupt wavy boundary.

R—60 to 70 inches (153 to 178 cm); common medium roots at top of horizon; hard Cedar Mesa Formation sandstone bedrock.

Range in Characteristics

A horizon
- Value: 5 or 6 dry, 4 or 5 moist
- Chroma: 3 or 4, dry or moist
- Texture: loamy fine sand, loamy sand
- Clay content: 1 to 10 percent
- Calcium carbonate equivalent: 0 to 5 percent
- Rock fragments: 15 to 45 percent gravel and cobbles

C or Bw horizons
- Hue: 2.5Y, 10YR
- Value: 5 to 8 dry, 4 or 6 moist
- Chroma: 3 to 6 dry, 4 or 6 moist
- Texture: sand, sandy loam
- Clay content: 1 to 10 percent
- Calcium carbonate equivalent: 0 to 5 percent
- Rock fragments: 35 to 70 percent gravel and cobbles

73—Levante family complex, 0 to 15 percent slopes

Map Unit Setting

General setting: Canyon bottoms in Natural Bridges National Monument
Elevation: 5,600 to 6,200 feet (1,707 to 1,890 meters)
Mean annual precipitation: 12 to 15 inches (305 to 369 millimeters)
Mean annual air temperature: 46 to 50 degrees F (7.8 to 10.0 degrees C)
Mean annual soil temperature: 48 to 52 degrees F (8.9 to 11.1 degrees C)
Frost-free period: 130 to 160 days
Major Land Resource Area: 36 – Southwestern Plateaus, Mesas, and Foothills

Map Unit Composition

Levante family and similar soils: 65 percent
Levante family, frequently flooded and similar soils: 20 percent
Minor components: (fig. 18)
- Cobbly riverwash in active stream channels, non-vegetated
- Sandy or sandy-skeletal Ustifluvents on narrow floodplains – Semi-wet Fresh Streambank (Fremont Cottonwood)

Figure 18.— Landscape of map unit 73 showing locations of Levante family soil, frequently flooded, and cobbly riverwash components.

- Very deep alluvial soils overlain with colluvium from the canyon walls on high terraces – Abandoned Terrace (Basin Big Sagebrush/Utah Juniper)
- Soils moderately deep and deep to bedrock

Soil Properties and Qualities

Levante family soils

Taxonomic classification: Sandy, mixed, mesic Aridic Ustifluvents (fig. 19)
Landform: High terraces (fig. 20)
Geology: Quaternary Alluvium
Parent material: alluvium derived from sandstone
Slope: 0 to 15 percent

Ground Cover:	(% Cover)
Plant Canopy:	40-70
Litter <5mm:	15-40
Rock fragments:	0-5
Bare soil:	0-5
Cyanobacteria Crust:	5-20
Lichen Crust:	10-30
Moss Crust:	5-20
Salt Crust:	0
Gypsum Crust:	0

Depth to restrictive feature(s): greater than 60 inches
Drainage class: excessively drained
Slowest permeability: 6.0 to 20 in/hr (rapid)
Available water capacity total inches: about 6.6 (moderate)

Figure 19— Profile of Levante family soil in map unit 73.

Shrink-swell potential: about 1.5 LEP (low)
Flooding hazard: occasional, very brief
Ponding hazard: none
Seasonal water table minimum depth: greater than 60 inches
Runoff class: very low
Hydrologic group: A
Calcium carbonate maximum: about 10 percent
Gypsum maximum: none
Salinity maximum: about 2 mmhos/cm (nonsaline)
Sodium adsorption ratio maximum: about 0 SAR (nonsodic)
Ecological site name: Loamy Terrace (Basin Big Sagebrush/Oakbrush)
Ecological site number: R036XY011UT
Present vegetation (in most areas): basin big sagebrush, Gambel oak, Indian ricegrass, Utah juniper, Utah serviceberry, muttongrass, needle and thread
Land capability (non irrigated): 6s

Typical Profile

Location
Geographic Coordinate System (Universal Transverse Mercator): 585,532 meters E, 4162,181 meters N, zone 12.

C1—0 to 4.5 inches (0 to 12 cm); reddish brown (5YR 5/4) loamy fine sand, reddish brown (5YR 4/3), moist; 6 percent clay; weak medium granular structure; soft, very friable, slightly sticky and nonplastic; common very fine and fine roots throughout; common very fine and fine irregular pores; very slightly effervescent; moderately alkaline, pH 8.1; abrupt smooth boundary.

C2—4.5 to 10 inches (12 to 25 cm); reddish brown (5YR 5/4) loamy fine sand, reddish brown (5YR 4/4), moist; 6 percent clay; weak coarse subangular blocky parting to weak medium subangular blocky structure; soft, very friable, slightly sticky and nonplastic; many very fine, common fine, and few medium roots throughout; common very fine and fine, and few medium tubular pores; slightly effervescent; moderately alkaline, pH 8.3; clear smooth boundary.

C3—10 to 35.5 inches (25 to 90 cm); yellowish red (5YR 5/6) loamy fine sand,

reddish brown (5YR 4/4), moist; 7 percent clay; weak thick platy structure; soft, very friable, slightly sticky and nonplastic; few very fine, common fine, and few medium roots throughout; common very fine and fine irregular, and few medium tubular pores; slightly effervescent; moderately alkaline, pH 8.3; abrupt smooth boundary.

C4—35.5 to 52 inches (90 to 132 cm); yellowish red (5YR 5/6) fine sand, yellowish red (5YR 4/6), moist; 4 percent clay; weak medium subangular blocky structure; slightly hard, friable, nonsticky and nonplastic; few fine and medium roots throughout; common very fine and fine tubular pores; strongly effervescent; moderately alkaline, pH 8.3; clear smooth boundary.

C5—52 to 71.5 inches (132 to 181 cm); yellowish red (5YR 5/6) fine sand, yellowish red (5YR 4/6), moist; 3 percent clay; single grain; loose, nonsticky and nonplastic; few fine roots throughout; common very fine and fine irregular pores; strongly effervescent; strongly alkaline, pH 8.5; clear smooth boundary.

C6—71.5 to 80.5 inches (181 to 204 cm); yellowish red (5YR 5/6) fine sand, reddish brown (5YR 4/4), moist; 4 percent clay; single grain; loose, nonsticky and nonplastic; few fine roots throughout; common very fine and fine irregular pores; slightly effervescent; strongly alkaline, pH 8.5.

Range in Characteristics

C horizon

Hue: 5YR, 7.5YR

Value: 4 or 5, dry or moist

Chroma: 3 to 6, dry or moist

Texture: stratified loamy fine sand, fine sand

Figure 20.— Typical landscape of Levante family soil in map unit 73. Vegetation includes perennial grasses, green Mormon tea, and Utah juniper.

Clay content: 1 to 10 percent
Calcium carbonate equivalent: 0 to 10 percent
Rock fragments: 0 to 35 percent gravel
Reaction: moderately alkaline or strongly alkaline (pH 7.9 to 9.0)

Some pedons contain Bw horizons that are too thin or too coarse to qualify as cambic horizons.

Levante family, frequently flooded soils
Taxonomic classification: Sandy, mixed, mesic Aridic Ustifluvents (fig. 21)
Landform: Flood-plain steps (fig. 22)
Geology: Quaternary Alluvium
Parent material: alluvium derived from sandstone
Slope: 0 to 6 percent

Ground Cover:	(% Cover)
Plant Canopy:	20-70
Litter <5mm:	10-35
Rock fragments:	0-20
Bare soil:	5-40
Cyanobacteria Crust:	1-10
Lichen Crust:	1-5
Moss Crust:	1-10
Salt Crust:	0
Gypsum Crust:	0

Depth to restrictive feature(s): greater than 60 inches to bedrock, lithic

Figure 21.— Profile of Levante family soil, frequently flooded, in map unit 73.

Figure 22.— Landscape of map unit 73 showing typical position of Levante family soil, frequently flooded. Note flood debris in cottonwood tree.

Drainage class: excessively drained
Slowest permeability: 6.0 to 20 in/hr (rapid)
Available water capacity total inches: about 4.7 (low)
Shrink-swell potential: about 1.5 LEP (low)
Flooding hazard: frequent, brief
Ponding hazard: none
Seasonal water table minimum depth: greater than 60 inches
Runoff class: very low
Hydrologic group: A
Calcium carbonate maximum: about 5 percent
Gypsum maximum: none
Salinity maximum: about 2 mmhos/cm (nonsaline)
Sodium adsorption ratio maximum: about 0 SAR (nonsodic)
Ecological site name: Semi-wet Fresh Streambank (Fremont Cottonwood)
Ecological site number: R036XY013UT
Present vegetation (in most areas): Fremont cottonwood, willow, Canada wildrye, basin big sagebrush, Baltic rush, fragrant sumac, skyrocket gilia
Land capability (non irrigated): 6w

Typical Profile

Location

Geographic Coordinate System (Universal Transverse Mercator): 585,720 meters E, 4162,211 meters N, zone 12.

C1—0 to 1.5 inches (0 to 4 cm); light reddish brown (5YR 6/4) loamy fine sand, reddish brown (5YR 4/4), moist; 6 percent clay; weak thin platy structure; soft, very friable, slightly sticky and nonplastic; many very fine, common fine, and few medium roots throughout; many very fine and fine irregular pores; slightly effervescent; moderately alkaline, pH 8.2; abrupt smooth boundary.

C2—1.5 to 7.5 inches (4 to 19 cm); pink (5YR 7/4) loamy fine sand, reddish yellow (5YR 6/6), moist; 5 percent clay; weak thick platy structure; soft, very friable, slightly sticky and nonplastic; common very fine and few fine roots throughout; common very fine and fine irregular pores; slightly effervescent; moderately alkaline, pH 8.3; abrupt smooth boundary.

Ab—7.5 to 9 inches (19 to 23 cm); light brown (7.5YR 6/4) loamy fine sand, brown (7.5YR 4/4), moist; 10 percent clay; weak medium subangular blocky structure; soft, friable, slightly sticky and nonplastic; common very fine, fine and medium roots throughout; common very fine and fine irregular pores; strongly effervescent; moderately alkaline, pH 8.3; abrupt smooth boundary.

C3—9 to 16.5 inches (23 to 42 cm); reddish yellow (7.5YR 7/6) sand, strong brown (7.5YR 5/6), moist; 2 percent clay; single grain; loose, nonsticky and nonplastic; few very fine, fine, medium roots at top of horizon; common very fine and few fine irregular pores; slightly effervescent; moderately alkaline, pH 8.4; abrupt smooth boundary.

C4—16.5 to 30.5 inches (42 to 77 cm); light brown (7.5YR 6/4) fine sand, brown (7.5YR 4/4), moist; 6 percent clay; massive; soft, friable, slightly sticky and nonplastic; common very fine, few fine, medium, and coarse, and common very coarse roots throughout; common very fine and fine, and few medium irregular pores; strongly effervescent; moderately alkaline, pH 8.4; clear smooth boundary.

Bw—30.5 to 41.5 inches (77 to 105 cm); reddish yellow (7.5YR 6/6) fine sand, strong brown (7.5YR 4/6), moist; 3 percent clay; weak coarse subangular blocky structure; soft, friable, nonsticky and nonplastic; few very fine, fine, and medium roots throughout; few very fine and fine irregular pores; strongly effervescent; strongly alkaline, pH 8.5; clear smooth boundary.

C5—41.5 to 61 inches (105 to 155 cm); reddish yellow (7.5YR 6/6) sand, strong brown (7.5YR 4/6), moist; 3 percent clay; single grain; loose, nonsticky and nonplastic; few fine roots throughout; common fine irregular pores; 8 percent gravel; strongly effervescent; strongly alkaline, pH 8.5; clear smooth boundary.

C6—61 to 65.5 inches (155 to 166 cm); yellowish red (5YR 6/6) fine sand, yellowish red (5YR 4/6), moist; 2 percent clay; single grain; loose, nonsticky and nonplastic; few fine roots throughout; common fine irregular pores; 10 percent gravel; strongly effervescent; moderately alkaline, pH 8.4.

Range in Characteristics

C horizon
- Hue: 5YR, 7.5YR
- Value: 5 to 7 dry, 4 to 6 moist
- Chroma: 4 or 6, dry or moist
- Texture: stratified loamy fine sand, fine sand, sand, coarse sand
- Clay content: 1 to 10 percent
- Calcium carbonate equivalent: 0 to 5 percent
- Rock fragments: 0 to 35 percent gravel
- Reaction: moderately alkaline or strongly alkaline (pH 7.9 to 9.0)

A or Ab horizons are present in some pedons. Some pedons have Bw horizons that are too thin or too coarse to qualify as cambic horizons.

74—Metuck very gravelly sandy loam, 25 to 65 percent slopes

Map Unit Setting

General setting: Red House Cliffs in western part of Natural Bridges National Monument (fig. 23)
Elevation: 5,900 to 6,600 feet (1,798 to 2,012 meters)
Mean annual precipitation: 12 to 15 inches (305 to 369 millimeters)
Mean annual air temperature: 46 to 50 degrees F (7.8 to 10.0 degrees C)
Mean annual soil temperature: 48 to 52 degrees F (8.9 to 11.1 degrees C)
Frost-free period: 130 to 160 days
Major Land Resource Area: 36 – Southwestern Plateaus, Mesas, and Foothills

Map Unit Composition

Metuck and similar soils: 90 percent
Minor components:
- Soils similar to Gladel near top of escarpments – Upland Shallow Loam (Pinyon/ Utah Juniper)

Soil Properties and Qualities

Metuck soils
Taxonomic classification: Loamy-skeletal, mixed, superactive, calcareous, mesic Aridic Lithic Ustorthents (fig. 24)

Figure 23.— Landscape of map unit 74 showing typical position of Metuck soil. Dominant vegetation includes Utah juniper, pinyon Fremont mahonia, and green Mormon tea.

Figure 24.— Profile of Metuck soil. Paralithic contact is at 13 centimeters, and lithic contact is at 35 centimeters.

Landform: Talus slopes, escarpments
Geology: Organ Rock Sandstone (Permian)
Parent material: colluvium derived from sandstone
Slope: 25 to 65 percent

Ground Cover:	(% Cover)
Plant Canopy:	20-45
Litter <5 mm:	5-15
Rock fragments:	20-45
Bare soil:	5-10
Cyanobacteria:	1-10
Lichen:	1-10
Moss:	1-10
Salt crust:	0
Gypsum crust:	0

Depth to restrictive feature(s): 4 to 10 inches to bedrock, paralithic; 6 to 20 inches to bedrock, lithic
Drainage class: somewhat excessively drained
Slowest permeability: 0.6 to 2.0 in/hr (moderate)
Available water capacity total inches: about 0.6 (very low)
Shrink-swell potential: about 1.5 LEP (low)
Flooding hazard: none
Ponding hazard: none
Seasonal water table minimum depth: greater than 6 feet

Runoff class: high
Hydrologic group: D
Calcium carbonate maximum: about 20 percent
Gypsum maximum: about 2 percent
Salinity maximum: about 1 mmhos/cm (nonsaline)
Sodium adsorption ratio maximum: about 0 SAR (nonsodic)
Ecological site name: Upland Very Steep Stony Loam (Pinyon/Utah Juniper)
Ecological site number: R036XY328UT
Present vegetation (in most areas): Salina wildrye, Utah juniper, Bigelow sagebrush, Utah serviceberry, mountain mahogany, roundleaf buffaloberry, Indian ricegrass, pinyon, fineleaf hymenopappus, galleta
Land capability (non irrigated): 7s

Typical Profile

Location

Geographic Coordinate System (Universal Transverse Mercator): 584,382 meters E, 4161,041 meters N, zone 12.

C1—0 to 1.5 inches (0 to 4 cm); yellowish red (5YR 4/6) very gravelly sandy loam, dark reddish brown (5YR 3/4), moist; 13 percent clay; massive; slightly hard, friable, slightly sticky and slightly plastic; many very fine and common fine roots throughout; many very fine and common fine tubular pores; 40 percent gravel; strongly effervescent; moderately alkaline, pH 8.0; abrupt wavy boundary.

C2—1.5 to 4.5 inches (4 to 12 cm); yellowish red (5YR 4/6) extremely gravelly loam, dark reddish brown (5YR 3/4), moist; 16 percent clay; massive; slightly hard, friable, slightly sticky and slightly plastic; many very fine and common fine roots throughout; many very fine and common fine tubular pores; 65 percent gravel; violently effervescent; moderately alkaline, pH 8.2; abrupt wavy boundary.

Cr—4.5 to 7.5 inches (12 to 19 cm); weathered Organ Rock Formation sandstone bedrock; common fine and medium roots at top of horizon and common medium roots in cracks; abrupt wavy boundary.

R—7.5 to 17.5 inches (19 to 44 cm); hard Organ Rock Formation sandstone bedrock.

Range in Characteristics

C1 horizon
Hue: 5YR, 7.5YR
Value: 4 or 5 dry, 3 moist
Chroma: 4 or 6, dry or moist
Clay content: 10 to 18 percent
Calcium carbonate equivalent: 1 to 10 percent
Rock fragments: 35 to 50 percent gravel

C2 horizon
Hue: 5YR, 7.5YR
Value: 4 or 5 dry, 3 or 4 moist
Chroma: 4 or 6, dry or moist
Clay content: 10 to 18 percent
Calcium carbonate equivalent: 5 to 20 percent
Rock fragments: 35 to 70 percent gravel

Use and Management of the Soils

This soil survey is an inventory and evaluation of the soils in the survey area. It can be used to adjust land uses to the limitations and potentials of natural resources and the environment. Also, it can help to prevent soil-related failures in land uses.

In preparing a soil survey, soil scientists, conservationists, engineers, and others collect extensive field data about the nature and behavioral characteristics of the soils. They collect data on erosion, droughtiness, flooding, and other factors that affect various soil uses and management. Field experience and collected data on soil properties and performance are used as a basis in predicting soil behavior.

Information in this section can be used to plan the use and management of soils for rangeland and forestland; as sites for buildings, sanitary facilities, and as wildlife habitat. It can be used to identify the potentials and limitations of each soil for specific land uses and to help prevent construction failures caused by unfavorable soil properties.

Planners and others using soil survey information can evaluate the effect of specific land uses on productivity and on the environment in all or part of the survey area. The survey can help planners to maintain or create a management plan in harmony with the natural soil.

Maintenance staff can use this survey to locate sources of sand and gravel, roadfill, and topsoil. They can use it to identify areas where bedrock, wetness, or very firm soil layers can cause difficulty in excavation.

Interpretive Ratings

The interpretive tables in this survey rate the soils in the survey area for various uses. Many of the tables identify the limitations that affect specified uses and indicate the severity of those limitations. The ratings in these tables are both verbal and numerical.

Rating Class Terms

Rating classes are expressed in the tables in terms that indicate the extent to which the soils are limited by all of the soil features that affect a specified use or in terms that indicate the suitability of the soils for the use. Thus, the tables may show limitation classes or suitability classes. Terms for the limitation classes are *not limited, somewhat limited,* and *very limited*. The suitability ratings are expressed as *well suited, moderately suited, poorly suited,* and *unsuited* or as *good, fair,* and *poor*.

Numerical Ratings

Numerical ratings in the tables indicate the relative severity of individual limitations. The ratings are shown as decimal fractions ranging from 0.00 to 1.00. They indicate gradations between the point at which a soil feature has the greatest negative impact on the use and the point at which the soil feature is not a limitation. The limitations appear in order from the most limiting to the least limiting. Thus, if more than one limitation is identified, the most severe limitation is listed first and the least severe one is listed last.

Prime Farmland

Prime farmland is one of several kinds of important farmland defined by the U.S. Department of Agriculture. It is of major importance in meeting the Nation's short- and long-range needs for food and fiber. Because the supply of high-quality farmland is limited, the U.S. Department of Agriculture recognizes that responsible levels of government, as well as individuals, should encourage and facilitate the wise use of our Nation's prime farmland.

Prime farmland, as defined by the U.S. Department of Agriculture, is land that has the best combination of physical and chemical characteristics for producing food, feed, forage, fiber, and oilseed crops and is available for these uses. It could be cultivated land, pastureland, forestland, or other land, but it is not urban or built-up land or water areas. The soil qualities, growing season, and moisture supply are those needed for the soil to economically produce sustained high yields of crops when proper management, including water management, and acceptable farming methods are applied. In general, prime farmland has an adequate and dependable supply of moisture from precipitation or irrigation, a favorable temperature and growing season, acceptable acidity or alkalinity, an acceptable salt and sodium content, and few or no rocks. It is permeable to water and air. It is not excessively erodible or saturated with water for long periods, and it either is not frequently flooded during the growing season or is protected from flooding. Slope ranges mainly from 0 to 6 percent. More detailed information about the criteria for prime farmland is available at the local office of the Natural Resources Conservation Service.

There are no soils in Natural Bridges National Monument that meet the criteria for Prime Farmland as defined by the U.S Department of Agriculture. Some of the reasons for disqualification are: excessive coarse fragments, high susceptibility to wind erosion, excessive slope, low available water capacity, excessive wetness, and high pH. Each soil identified in Natural Bridges National Monument does not meet the requirements for Prime Farmland for one or more of the above reasons.

Rangeland and Woodland Understory Vegetation

Areas that have similar climate and topography, differences in the kind and amount of rangeland or forest understory vegetation are closely related to the soil. Effective management is based on the relationship between the soils, vegetation, and water. Rangeland is typically defined as a type of land that supports vegetation suitable for grazing (grasses, forbs, and shrubs) and is managed by ecological, rather than agronomic methods. However, for this survey, the term rangeland is used loosely to describe all land that produces any type of vegetation and is managed by ecological rather than agronomic methods. Therefore all soil components that support vegetation are assigned an ecological site which details the relationship between the soils, vegetation, and water.

Table 6 includes map unit and details for each soil component, including the ecological site, existing vegetation at the time of the survey, estimated total annual production of the existing vegetation in favorable, normal, and unfavorable years, and typical percentage of dominant species measured by annual production.

Landscapes are divided into ecological sites for the purposes of inventory, evaluation, and management. An *ecological site* is a distinctive kind of land with specific physical characteristics that differs from other kinds of land in its ability to produce a distinctive kind and amount of vegetation. An ecological site is the product of all environmental factors responsible for its development. It has characteristic soils that developed over time including characteristic hydrology. Hydrology is influenced by soil and plant community development and typically describes infiltration and permeability rates. The vegetation, soils, and hydrology are interrelated and influence each other. The plant community on an ecological site is typified by an association of

species that differs from that of other ecological sites in the kind and/or proportion of species or in total production. The ecological site description contains details about the characteristic soils, plant community, different steady states that are expected, possible transitions, and site interpretations. For a full ecological site description that includes a state and transition model, refer to ESIS at http://esis.sc.egov.usda.gov . You may also refer to the Ecological Site Description Report for Natural Bridges National Monument.

Total dry-weight production is the amount of vegetation that can be expected to grow annually in a well managed area that supports the existing plant community at the time of the survey. It includes all a current year's vegetative growth of leaves, twigs, flowers, and fruits, whether or not it is palatable to grazing animals. It does not include the increase in stem diameter of trees and shrubs. Estimated total annual production values, in pounds per acre of air-dry vegetation, is given for favorable, normal, and unfavorable years. In a favorable year, the amount and distribution of precipitation and the temperatures make growing conditions substantially better than average. In a normal year, growing conditions are about average. In an unfavorable year, growing conditions are well below average, generally because of low available soil moisture. Yields are adjusted to a common percent of air-dry moisture content.

Characteristic plants—this column reports the dominant grasses, forbs, shrubs and trees by annual production of the existing plant community at the time of the survey.

Composition— this column gives the typical percentage of the total annual production for the dominant species of the existing vegetation. The amount that can be used as forage depends on the grazing animals and grazing season.

Information about rangeland management, including range similarity index and rangeland trend, is available in chapter 4 of the "National Range and Pasture Handbook" available on the Internet at http://www.glti.nrcs.usda.gov/technical/publications/nrph.html.

Tables 7 and 8 show the common plants in the survey area. In table 7 they are sorted by plant symbol, and in table 8 they are listed in order of local common name.

The native rangeland and forest understory ecological sites are described in the paragraphs that follow and illustrated in figures 25 through 32.

Figure 25.—R036XY011UT – Loamy Terrace (Basin Big Sagebrush/Oakbrush)

This ecological site occurs on high stream terraces on very deep, well to excessively drained soils, where slopes usually range from 0 to 15 percent but occasionally reach 25 percent. The parent material is primarily alluvial and sandy in nature, although some limited colluvial influence (from the cliffs above) is present in some areas. Flooding frequency is occasional and very brief, and available water capacity is moderate. Runoff is generally very low. Typical native plant species include basin big sagebrush *(Artemisia tridentata ssp. tridentata)*, oakbrush *(Quercus L.)*, rabbitbrush *(Ericameria nauseosa)*, Indian ricegrass *(Achnatherum hymenoides)*, needle and thread *(Hesperostipa comata)*, and several forbs (fig. 25).

Figure 26.—R036XY013UT – Semi-wet Fresh Streambank (Fremont Cottonwood)

This ecological site occurs along perennial, intermittent, and ephemeral drainages. The site includes the stream channel and flood-plain steps. Slopes range from 0 to 6 percent, and the soils are very deep. The parent material is primarily alluvial in nature. Flooding is frequent and brief. Available water capacity is low because the parent material is sandy, but there is sufficient underground water flow to support woody obligate riparian species. Runoff is very low. Typical native plant species include Fremont cottonwood (*Populus fremontii*), coyote willow (*Salix* exigua), other willow species (*Salix spp.*), slender wheatgrass (*Elymus trachycaulus spp. trachycaulus*), and sand dropseed (*Sporobolus cryptandrus*) (fig. 26).

Figure 27.—R036XY302UT – Upland Dissected Slope (Pinyon/Utah Juniper)

This ecological site occurs in areas of “breaks,” landscape positions that are intermediate between the flat, deep mesa tops and the shallower soils near the edges of canyons. Breaks increase the likelihood of erosion and soil loss, resulting in rolling topography and variation in soil depth. The parent material is eolian in origin. The soils are loamy and well drained, and range in depth from moderately deep to very deep to hard sandstone bedrock. The slope ranges from 20 to 50 percent. Runoff is high. Typical native plant species include twoneedle pinyon *(Pinus edulis)*, Utah juniper *(Juniperus osteosperma)*, roundleaf buffaloberry *(Shepherdia rotundifolia)*, and jointfir species *(Ephedra spp.)* (fig. 27).

Figure 28.—R036XY306UT – Upland Loam (Big Sagebrush)

This ecological site occurs on very deep, loamy soils on mesas, where slopes range from 2 to 8 percent. Soils are well drained, and are eolian in origin. Available water capacity is high, and runoff is low. Typical native plant species include big sagebrush (*Artemisia tridentata*), snakeweed (*Gutierrezia sarothrae*), twoneedle pinyon (*Pinus edulis*), Utah juniper (*Juniperus osteosperma*), and jointfir species (*Ephedra spp.*), although when Utah juniper and pinyon occur on this site, it is no longer in the reference state (fig. 28).

Figure 29.—R036XY307UT – Upland Loam (Pinyon/Utah Juniper)

This ecological site occurs on slightly to moderately sloping regions of the mesa top. Soils are very deep and loamy, and slopes range from 2 to 15 percent. Available water capacity is moderate, and runoff is very low or low. The parent material is eolian. Typical native plant species include twoneedle pinyon pine (*Pinus edulis*), Utah Juniper (*Juniperus osteosperma*), with sparse big sagebrush (*Artemisia tridentata*), jointfir species (*Ephedra spp.*), broom snakeweed (*Gutierrezia sarothrae*), and bottlebrush squirreltail (*Elymus elymoides*) (fig. 29).

Figure 30.—R036XY315UT – Upland Shallow Loam (Pinyon/Utah Juniper)

This ecological site occurs on shallow soils on mesas and structural benches, where slopes range from 2 to 15 percent. These loamy, well drained soils are eolian in origin. Available water capacity is very low, and runoff is medium. Depth to hard sandstone bedrock is less than 20 inches. Typical native plant species include twoneedle pinyon (*Pinus edulis*), Utah Juniper (*Juniperus osteosperma*), jointfir species (*Ephedra spp.*), broom snakeweed (*Gutierrezia sarothrae*), and lobeleaf groundsel (*Packera multilobata*) (fig. 30).

Figure 31.—R036XY316UT – Upland Shallow Loam (Littleleaf Mountain Mahogany)

This ecological site occurs on shallow soils on ledges and structural benches of the canyon wall, and at edges of mesas; the site receives run-in water from the adjacent impervious surfaces. The soils are loamy and well drained, and slopes range from 5 to 15 percent. Available water capacity is very low, and runoff is medium. Depth to hard bedrock is less than 20 inches. Typical native plant species include twoneedle pinyon (*Pinus edulis*), Utah juniper (*Juniperus osteosperma*), littleleaf mountain mahogany (*Cercocarpus intricatus*), Indian ricegrass (*Achnatherum hymenoides*), and numerous forbs (fig. 31).

Figure 32.—R036XY328UT – Upland Very Steep Stony Loam (Pinyon/Utah Juniper)

This ecological site occurs on steep canyon walls, where slopes range from 20 to 75 percent. Soils are variable in depth, ranging from shallow to very deep. The parent material is sandstone colluvium, and the surface is covered with up to 50 percent gravel, stones and boulders. The soils are somewhat excessively to excessively drained, available water capacity is very low, and runoff ranges from low to high. Typical native plants include twoneedle pinyon (*Pinus edulis*), Utah juniper (*Juniperus osteosperma*), Saline wildrye (*Leymus salinus*), Indian ricegrass (*Achnatherum hymenoides*), and Utah serviceberry (*Amelanchier utahensis*) (fig. 32).

Forest Productivity and Land Management

The tables in this section can help forest owners or managers plan the use of soils for wood crops. They show the potential productivity of the soils for wood crops and rate the soils according to the limitations that affect various aspects of forest management.

Forest Productivity

In table 9, the *potential productivity* of merchantable or *common trees* on a soil is expressed as a site index and as a volume number. The *site index* is the average height, in feet, that dominant and codominant trees of a given species attain in a specified number of years. The site index applies to fully stocked, even-aged, unmanaged stands. Commonly grown trees are those that forest managers generally favor in intermediate or improvement cuttings. They are selected on the basis of growth rate, quality, value, and marketability. More detailed information regarding site index is available in the "National Forestry Manual," which is available in local offices of the Natural Resources Conservation Service or on the Internet at http://soils.usda.gov/technical/nfmanual/.

The *volume of wood fiber*, a number, is the yield likely to be produced by the most important tree species. This number, expressed as cubic feet per acre per year and calculated at the age of culmination of the mean annual increment (CMAI), indicates the amount of fiber produced in a fully stocked, even-aged, unmanaged stand.

Land Management

In tables 10 through 13, interpretive ratings are given for various aspects of land management. The ratings are both verbal and numerical.

Some rating class terms indicate the degree to which the soils are suited to a specified land management practice. *Well suited* indicates that the soil has features that are favorable for the specified practice and has no limitations. Good performance can be expected, and little or no maintenance is needed. *Moderately suited* indicates that the soil has features that are moderately favorable for the specified practice. One or more soil properties are less than desirable, and fair performance can be expected. Some maintenance is needed. *Poorly suited* indicates that the soil has one or more properties that are unfavorable for the specified practice. Overcoming the unfavorable properties requires special design, extra maintenance, and costly alteration. *Unsuited* indicates that the expected performance of the soil is unacceptable for the specified practice or that extreme measures are needed to overcome the undesirable soil properties.

Numerical ratings in the tables indicate the severity of individual limitations. The ratings are shown as decimal fractions ranging from 0.01 to 1.00. They indicate gradations between the point at which a soil feature has the greatest negative impact on the specified land management practice (1.00) and the point at which the soil feature is not a limitation (0.00).

Rating class terms for fire damage and seedling mortality are expressed as *low, moderate,* and *high*. Where these terms are used, the numerical ratings indicate gradations between the point at which the potential for fire damage or seedling mortality is highest (1.00) and the point at which the potential is lowest (0.00).

The paragraphs that follow indicate the soil properties considered in rating the soils for land management practices. More detailed information about the criteria used in the ratings is available in the "National Forestry Manual," which is available in local offices of the Natural Resources Conservation Service or on the Internet (http://nsscnt.nssc.nrcs.usda.gov/nfm/).

In table 10, ratings in the columns *suitability for hand planting* and *suitability for mechanical planting* are based on slope, depth to a restrictive layer, content of sand, plasticity index, rock fragments on or below the surface, depth to a water table, and ponding. The soils are described as well suited, moderately suited, poorly suited, or unsuited to these methods of planting. It is assumed that necessary site preparation is completed before seedlings are planted.

Ratings in the column *soil rutting hazard* are based on depth to a water table, rock fragments on or below the surface, the Unified classification, depth to a restrictive layer, and slope. Ruts form as a result of the operation of forest equipment. The hazard is described as slight, moderate, or severe. A rating of *slight* indicates that the soil is subject to little or no rutting, *moderate* indicates that rutting is likely, and *severe* indicates that ruts form readily.

In table 11, ratings in the column *hazard of off-road or off-trail erosion* are based on slope and on soil erodibility factor K. The soil loss is caused by sheet or rill erosion in off-road or off-trail areas where 50 to 75 percent of the surface has been exposed by logging, grazing, mining, or other kinds of disturbance. The hazard is described as slight, moderate, severe, or very severe. A rating of *slight* indicates that erosion is unlikely under ordinary climatic conditions; *moderate* indicates that some erosion is likely and that erosion-control measures may be needed; *severe* indicates that erosion is very likely and that erosion-control measures, including revegetation of

bare areas, are advised; and *very severe* indicates that significant erosion is expected, loss of soil productivity and off-site damage are likely, and erosion-control measures are costly and generally impractical.

Ratings in the column *hazard of erosion on roads and trails* are based on the soil erodibility factor K, slope, and content of rock fragments. The ratings apply to unsurfaced roads and trails. The hazard is described as slight, moderate, or severe. A rating of *slight* indicates that little or no erosion is likely; *moderate* indicates that some erosion is likely, that the roads or trails may require occasional maintenance, and that simple erosion-control measures are needed; and *severe* indicates that significant erosion is expected, that the roads or trails require frequent maintenance, and that costly erosion-control measures are needed.

Ratings in the column *suitability for roads (natural surface)* are based on slope, rock fragments on the surface, plasticity index, content of sand, the Unified classification, depth to a water table, ponding, flooding, and the hazard of soil slippage. The ratings indicate the suitability for using the natural surface of the soil for roads. The soils are described as well suited, moderately suited, or poorly suited to this use.

In table 12, ratings in the columns *suitability for mechanical site preparation (surface)* are based on slope, depth to a restrictive layer, plasticity index, rock fragments on or below the surface, depth to a water table, and ponding. The soils are described as well suited, moderately suited, poorly suited, or unsuited to this management activity. The part of the soil from the surface to a depth of about 1 foot is considered in the ratings.

Ratings in the column *suitability for mechanical site preparation (deep)* are based on slope, depth to a restrictive layer, rock fragments on or below the surface, depth to a water table, and ponding. The soils are described as well suited, moderately suited, or poorly suited to this management activity. The part of the soil from the surface to a depth of about 3 feet is considered in the ratings.

In table 13, ratings in the column *potential for damage to soil by fire* are based on texture of the surface layer, content of rock fragments and organic matter in the surface layer, thickness of the surface layer, and slope. The soils are described as having a low, moderate, or high potential for this kind of damage. The ratings indicate an evaluation of the potential impact of prescribed fires or wildfires that are intense enough to remove the duff layer and consume organic matter in the surface layer.

Ratings in the column *potential for seedling mortality* are based on flooding, ponding, depth to a water table, content of lime, reaction, salinity, available water capacity, soil moisture regime, soil temperature regime, aspect, and slope. The soils are described as having a low, moderate, or high potential for seedling mortality.

Engineering

This section provides information for planning land uses related to urban development and to water management. Soils are rated for various uses, and the most limiting features are identified. Ratings are given for building site development, sanitary facilities, construction materials, and water management. The ratings are based on observed performance of the soils and on the data in the tables described under the heading “Soil Properties.”

Information in this section is intended for land use planning, for evaluating land use alternatives, and for planning site investigations prior to design and construction. The information, however, has limitations. For example, estimates and other data generally apply only to that part of the soil between the surface and a depth of 5 to 7 feet. Because of the map scale, small areas of different soils may be included within the mapped areas of a specific soil.

The information is not site specific and does not eliminate the need for onsite

investigation of the soils or for testing and analysis by personnel experienced in the design and construction of engineering works.

Government ordinances and regulations that restrict certain land uses or impose specific design criteria were not considered in preparing the information in this section. Local ordinances and regulations should be considered in planning, in site selection, and in design.

Soil properties, site features, and observed performance were considered in determining the ratings in this section. During the fieldwork for this soil survey, determinations were made about particle-size distribution, liquid limit, plasticity index, soil reaction, depth to bedrock, hardness of bedrock within 5 to 7 feet of the surface, soil wetness, depth to a water table, ponding, slope, likelihood of flooding, natural soil structure aggregation, and soil density. Data were collected about kinds of clay minerals, mineralogy of the sand and silt fractions, and the kinds of adsorbed cations. Estimates were made for erodibility, permeability, corrosivity, shrink-swell potential, available water capacity, and other behavioral characteristics affecting engineering uses.

This information can be used to evaluate the potential of areas for residential, commercial, industrial, and recreational uses; make preliminary estimates of construction conditions; evaluate alternative routes for roads, streets, highways, pipelines, and underground cables; evaluate alternative sites for sanitary landfills, septic tank absorption fields, and sewage lagoons; plan detailed onsite investigations of soils and geology; locate potential sources of gravel, sand, earthfill, and topsoil; plan drainage systems, irrigation systems, ponds, terraces, and other structures for soil and water conservation; and predict performance of proposed small structures and pavements by comparing the performance of existing similar structures on the same or similar soils.

The information in the tables, along with the soil maps, the soil descriptions, and other data provided in this survey, can be used to make additional interpretations.

Some of the terms used in this soil survey have a special meaning in soil science and are defined in the Glossary.

Recreation

The soils of the survey area are rated in tables 14 and 15 according to limitations that affect their suitability for recreation. The ratings are both verbal and numerical. Rating class terms indicate the extent to which the soils are limited by all of the soil features that affect the recreational uses. *Not limited* indicates that the soil has features that are very favorable for the specified use. Good performance and very low maintenance can be expected. *Somewhat limited* indicates that the soil has features that are moderately favorable for the specified use. The limitations can be overcome or minimized by special planning, design, or installation. Fair performance and moderate maintenance can be expected. *Very limited* indicates that the soil has one or more features that are unfavorable for the specified use. The limitations generally cannot be overcome without major soil reclamation, special design, or expensive installation procedures. Poor performance and high maintenance can be expected.

Numerical ratings in the tables indicate the severity of individual limitations. The ratings are shown as decimal fractions ranging from 0.01 to 1.00. They indicate gradations between the point at which a soil feature has the greatest negative impact on the use (1.00) and the point at which the soil feature is not a limitation (0.00).

The ratings in the tables are based on restrictive soil features, such as wetness, slope, and texture of the surface layer. Susceptibility to flooding is considered. Not considered in the ratings, but important in evaluating a site, are the location and accessibility of the area, the size and shape of the area and its scenic quality, vegetation, access to water, potential water impoundment sites, and access to public

sewer lines. The capacity of the soil to absorb septic tank effluent and the ability of the soil to support vegetation also are important. Soils that are subject to flooding are limited for recreational uses by the duration and intensity of flooding and the season when flooding occurs. In planning recreational facilities, onsite assessment of the height, duration, intensity, and frequency of flooding is essential.

The information in tables 14 and 15 can be supplemented by other information in this survey, for example, interpretations for building site development, construction materials, sanitary facilities, and water management.

In table 14, *camp areas* require site preparation, such as shaping and leveling the tent and parking areas, stabilizing roads and intensively used areas, and installing sanitary facilities and utility lines. Camp areas are subject to heavy foot traffic and some vehicular traffic. The ratings are based on the soil properties that affect the ease of developing camp areas and the performance of the areas after development. Slope, stoniness, and depth to bedrock or a cemented pan are the main concerns affecting the development of camp areas. The soil properties that affect the performance of the areas after development are those that influence trafficability and promote the growth of vegetation, especially in heavily used areas. For good trafficability, the surface of camp areas should absorb rainfall readily, remain firm under heavy foot traffic, and not be dusty when dry. The soil properties that influence trafficability are texture of the surface layer, depth to a water table, ponding, flooding, permeability, and large stones. The soil properties that affect the growth of plants are depth to bedrock or a cemented pan, permeability, and toxic substances in the soil.

Picnic areas are subject to heavy foot traffic. Most vehicular traffic is confined to access roads and parking areas. The ratings are based on the soil properties that affect the ease of developing picnic areas and that influence trafficability and the growth of vegetation after development. Slope and stoniness are the main concerns affecting the development of picnic areas. For good trafficability, the surface of picnic areas should absorb rainfall readily, remain firm under heavy foot traffic, and not be dusty when dry. The soil properties that influence trafficability are texture of the surface layer, depth to a water table, ponding, flooding, permeability, and large stones. The soil properties that affect the growth of plants are depth to bedrock or a cemented pan, permeability, and toxic substances in the soil.

In table 15, *foot traffic and equestrian trails* for hiking and horseback riding should require little or no slope modification through cutting and filling. The ratings are based on the soil properties that affect trafficability and erodibility. These properties are stoniness, depth to a water table, ponding, flooding, slope, and texture of the surface layer.

Mountain bike and off-road vehicle trails require little or no site preparation. They are not covered with surfacing material or vegetation. Considerable compaction of the soil material is likely. The ratings are based on the soil properties that influence erodibility, trafficability, dustiness, and the ease of revegetation. These properties are stoniness, slope, depth to a water table, ponding, flooding, and texture of the surface layer.

Building Site Development

Soil properties influence the development of building sites, including the selection of the site, the design of the structure, construction, performance after construction, and maintenance. Tables 16 and 17 show the degree and kind of soil limitations that affect dwellings with and without basements, small commercial buildings, local roads and streets, and shallow excavations.

The ratings in the tables are both verbal and numerical. Rating class terms indicate the extent to which the soils are limited by all of the soil features that affect building site development. *Not limited* indicates that the soil has features that are very favorable for the specified use. Good performance and very low maintenance can be

expected. *Somewhat limited* indicates that the soil has features that are moderately favorable for the specified use. The limitations can be overcome or minimized by special planning, design, or installation. Fair performance and moderate maintenance can be expected. *Very limited* indicates that the soil has one or more features that are unfavorable for the specified use. The limitations generally cannot be overcome without major soil reclamation, special design, or expensive installation procedures. Poor performance and high maintenance can be expected.

Numerical ratings in the tables indicate the severity of individual limitations. The ratings are shown as decimal fractions ranging from 0.01 to 1.00. They indicate gradations between the point at which a soil feature has the greatest negative impact on the use (1.00) and the point at which the soil feature is not a limitation (0.00).

In table 16, *dwellings* are single-family houses of three stories or less. For dwellings without basements, the foundation is assumed to consist of spread footings of reinforced concrete built on undisturbed soil at a depth of 2 feet or at the depth of maximum frost penetration, whichever is deeper. For dwellings with basements, the foundation is assumed to consist of spread footings of reinforced concrete built on undisturbed soil at a depth of about 7 feet. The ratings for dwellings are based on the soil properties that affect the capacity of the soil to support a load without movement and on the properties that affect excavation and construction costs. The properties that affect the load-supporting capacity include depth to a water table, ponding, flooding, subsidence, linear extensibility (shrink-swell potential), and compressibility. Compressibility is inferred from the Unified classification. The properties that affect the ease and amount of excavation include depth to a water table, ponding, flooding, slope, depth to bedrock or a cemented pan, hardness of bedrock or a cemented pan, and the amount and size of rock fragments.

Small commercial buildings are structures that are less than three stories high and do not have basements. The foundation is assumed to consist of spread footings of reinforced concrete built on undisturbed soil at a depth of 2 feet or at the depth of maximum frost penetration, whichever is deeper. The ratings are based on the soil properties that affect the capacity of the soil to support a load without movement and on the properties that affect excavation and construction costs. The properties that affect the load-supporting capacity include depth to a water table, ponding, flooding, subsidence, linear extensibility (shrink-swell potential), and compressibility (which is inferred from the Unified classification). The properties that affect the ease and amount of excavation include flooding, depth to a water table, ponding, slope, depth to bedrock or a cemented pan, hardness of bedrock or a cemented pan, and the amount and size of rock fragments.

In table 17, *local roads and streets* have an all-weather surface and carry automobile and light truck traffic all year. They have a subgrade of cut or fill soil material; a base of gravel, crushed rock, or soil material stabilized by lime or cement; and a surface of flexible material (asphalt), rigid material (concrete), or gravel with a binder. The ratings are based on the soil properties that affect the ease of excavation and grading and the traffic-supporting capacity. The properties that affect the ease of excavation and grading are depth to bedrock or a cemented pan, hardness of bedrock or a cemented pan, depth to a water table, ponding, flooding, the amount of large stones, and slope. The properties that affect the traffic-supporting capacity are soil strength (as inferred from the AASHTO group index number), subsidence, linear extensibility (shrink-swell potential), the potential for frost action, depth to a water table, and ponding.

Shallow excavations are trenches or holes dug to a maximum depth of 5 or 6 feet for graves, utility lines, open ditches, or other purposes. The ratings are based on the soil properties that influence the ease of digging and the resistance to sloughing. Depth to bedrock or a cemented pan, hardness of bedrock or a cemented pan, the amount of large stones, and dense layers influence the ease of digging, filling, and

compacting. Depth to the seasonal high water table, flooding, and ponding may restrict the period when excavations can be made. Slope influences the ease of using machinery. Soil texture, depth to the water table, and linear extensibility (shrink-swell potential) influence the resistance to sloughing.

Sanitary Facilities

Table 18 shows the degree and kind of soil limitations that affect septic tank absorption fields and sewage lagoons. The ratings are both verbal and numerical. Rating class terms indicate the extent to which the soils are limited by all of the soil features that affect these uses. *Not limited* indicates that the soil has features that are very favorable for the specified use. Good performance and very low maintenance can be expected. *Somewhat limited* indicates that the soil has features that are moderately favorable for the specified use. The limitations can be overcome or minimized by special planning, design, or installation. Fair performance and moderate maintenance can be expected. *Very limited* indicates that the soil has one or more features that are unfavorable for the specified use. The limitations generally cannot be overcome without major soil reclamation, special design, or expensive installation procedures. Poor performance and high maintenance can be expected.

Numerical ratings in the tables indicate the severity of individual limitations. The ratings are shown as decimal fractions ranging from 0.01 to 1.00. They indicate gradations between the point at which a soil feature has the greatest negative impact on the use (1.00) and the point at which the soil feature is not a limitation (0.00).

In table 18, *septic tank absorption fields* are areas in which effluent from a septic tank is distributed into the soil through subsurface tiles or perforated pipe. Only that part of the soil between depths of 24 and 60 inches is evaluated. The ratings are based on the soil properties that affect absorption of the effluent, construction and maintenance of the system, and public health. Permeability, depth to a water table, ponding, depth to bedrock or a cemented pan, and flooding affect absorption of the effluent. Stones and boulders, ice, and bedrock or a cemented pan interfere with installation. Subsidence interferes with installation and maintenance. Excessive slope may cause lateral seepage and surfacing of the effluent in downslope areas.

Some soils are underlain by loose sand and gravel or fractured bedrock at a depth of less than 4 feet below the distribution lines. In these soils the absorption field may not adequately filter the effluent, particularly when the system is new. As a result, the ground water may become contaminated.

Sewage lagoons are shallow ponds constructed to hold sewage while aerobic bacteria decompose the solid and liquid wastes. Lagoons should have a nearly level floor surrounded by cut slopes or embankments of compacted soil. Nearly impervious soil material for the lagoon floor and sides is required to minimize seepage and contamination of ground water. Considered in the ratings are slope, permeability, depth to a water table, ponding, depth to bedrock or a cemented pan, flooding, large stones, and content of organic matter.

Soil permeability is a critical property affecting the suitability for sewage lagoons. Most porous soils eventually become sealed when they are used as sites for sewage lagoons. Until sealing occurs, however, the hazard of pollution is severe. Soils that have a permeability rate of more than 2 inches per hour are too porous for the proper functioning of sewage lagoons. In these soils, seepage of the effluent can result in contamination of the ground water. Ground water contamination is also a hazard if fractured bedrock is within a depth of 40 inches, if the water table is high enough to raise the level of sewage in the lagoon, or if floodwater overtops the lagoon.

A high content of organic matter is detrimental to proper functioning of the lagoon because it inhibits aerobic activity. Slope, bedrock, and cemented pans can cause construction problems, and large stones can hinder compaction of the lagoon floor. If the lagoon is to be uniformly deep throughout, the slope must be gentle enough and

the soil material must be thick enough over bedrock or a cemented pan to make land smoothing practical.

Construction Materials

Tables 19 and 20 give information about the soils as potential sources of gravel, sand, topsoil, reclamation material, and roadfill. Normal compaction, minor processing, and other standard construction practices are assumed.

In table 19, *sand* and *gravel* are natural aggregates suitable for commercial use with a minimum of processing. They are used in many kinds of construction. Specifications for each use vary widely. In table 19, only the likelihood of finding material in suitable quantity is evaluated. The suitability of the material for specific purposes is not evaluated, nor are factors that affect excavation of the material. The properties used to evaluate the soil as a source of sand or gravel are gradation of grain sizes (as indicated by the Unified classification of the soil), the thickness of suitable material, and the content of rock fragments. If the bottom layer of the soil contains sand or gravel, the soil is considered a likely source regardless of thickness. The assumption is that the sand or gravel layer below the depth of observation exceeds the minimum thickness.

The soils are rated *good, fair,* or *poor* as potential sources of sand and gravel. A rating of *good* or *fair* means that the source material is likely to be in or below the soil. The bottom layer and the thickest layer of the soils are assigned numerical ratings. These ratings indicate the likelihood that the layer is a source of sand or gravel. The number 0.00 indicates that the layer is a poor source. The number 1.00 indicates that the layer is a good source. A number between 0.00 and 1.00 indicates the degree to which the layer is a likely source.

The soils are rated *good, fair,* or *poor* as potential sources of topsoil, reclamation material, and roadfill. The features that limit the soils as sources of these materials are specified in the tables. The numerical ratings given after the specified features indicate the degree to which the features limit the soils as sources of topsoil, reclamation material, or roadfill. The lower the number, the greater the limitation.

In table 20, *reclamation material* is used in areas that have been drastically disturbed by surface mining or similar activities. When these areas are reclaimed, layers of soil material or unconsolidated geological material, or both, are replaced in a vertical sequence. The reconstructed soil favors plant growth. The ratings in the table do not apply to quarries and other mined areas that require an offsite source of reconstruction material. The ratings are based on the soil properties that affect erosion and stability of the surface and the productive potential of the reconstructed soil. These properties include the content of sodium, salts, and calcium carbonate; reaction; available water capacity; erodibility; texture; content of rock fragments; and content of organic matter and other features that affect fertility.

Roadfill is soil material that is excavated in one place and used in road embankments in another place. In this table, the soils are rated as a source of roadfill for low embankments, generally less than 6 feet high and less exacting in design than higher embankments.

The ratings are for the whole soil, from the surface to a depth of about 5 feet. It is assumed that soil layers will be mixed when the soil material is excavated and spread.

The ratings are based on the amount of suitable material and on soil properties that affect the ease of excavation and the performance of the material after it is in place. The thickness of the suitable material is a major consideration. The ease of excavation is affected by large stones, depth to a water table, and slope. How well the soil performs in place after it has been compacted and drained is determined by its strength (as inferred from the AASHTO classification of the soil) and linear extensibility (shrink-swell potential).

Topsoil is used to cover an area so that vegetation can be established and maintained. The upper 40 inches of a soil is evaluated for use as topsoil. Also evaluated is the reclamation potential of the borrow area. The ratings are based on the soil properties that affect plant growth; the ease of excavating, loading, and spreading the material; and reclamation of the borrow area. Toxic substances, soil reaction, and the properties that are inferred from soil texture, such as available water capacity and fertility, affect plant growth. The ease of excavating, loading, and spreading is affected by rock fragments, slope, depth to a water table, soil texture, and thickness of suitable material. Reclamation of the borrow area is affected by slope, depth to a water table, rock fragments, depth to bedrock or a cemented pan, and toxic material.

The surface layer of most soils is generally preferred for topsoil because of its organic matter content. Organic matter greatly increases the absorption and retention of moisture and nutrients for plant growth.

Soil Properties

Data relating to soil properties are collected during the course of the soil survey.

Soil properties are ascertained by field examination of the soils and by laboratory index testing of some benchmark soils. Established standard procedures are followed. During the survey, many shallow borings are made and examined to identify and classify the soils and to delineate them on the soil maps.

Estimates of soil properties are based on field examinations, on laboratory tests of samples from the survey area, and on laboratory tests of samples of similar soils in nearby areas. Tests verify field observations, verify properties that cannot be estimated accurately by field observation, and help to characterize key soils.

The estimates of soil properties are shown in tables. They include engineering index properties, physical and chemical properties, and pertinent soil and water features.

Engineering Index Properties

Table 21 gives the engineering classifications and the range of index properties for the layers of each soil in the survey area.

Depth to the upper and lower boundaries of each layer is indicated.

Texture is given in the standard terms used by the U.S. Department of Agriculture. These terms are defined according to percentages of sand, silt, and clay in the fraction of the soil that is less than 2 millimeters in diameter. "Loam," for example, is soil that is 7 to 27 percent clay, 28 to 50 percent silt, and less than 52 percent sand. If the content of particles coarser than sand is 15 percent or more, an appropriate modifier is added, for example, "gravelly." Textural terms are defined in the Glossary.

Classification of the soils is determined according to the Unified soil classification system (ASTM, 2001) and the system adopted by the American Association of State Highway and Transportation Officials (AASHTO, 2000).

The Unified system classifies soils according to properties that affect their use as construction material. Soils are classified according to particle-size distribution of the fraction less than 3 inches in diameter and according to plasticity index, liquid limit, and organic matter content. Sandy and gravelly soils are identified as GW, GP, GM, GC, SW, SP, SM, and SC; silty and clayey soils as ML, CL, OL, MH, CH, and OH; and highly organic soils as PT. Soils exhibiting engineering properties of two groups can have a dual classification, for example, CL-ML.

The AASHTO system classifies soils according to those properties that affect roadway construction and maintenance. In this system, the fraction of a mineral soil that is less than 3 inches in diameter is classified in one of seven groups from A-1 through A-7 on the basis of particle-size distribution, liquid limit, and plasticity index. Soils in group A-1 are coarse grained and low in content of fines (silt and clay). At the other extreme, soils in group A-7 are fine grained. Highly organic soils are classified in group A-8 on the basis of visual inspection.

Rock fragments larger than 10 inches in diameter and 3 to 10 inches in diameter are indicated as a percentage of the total soil on a dry-weight basis. The percentages

are estimates determined mainly by converting volume percentage in the field to weight percentage.

Percentage (of soil particles) passing designated sieves is the percentage of the soil fraction less than 3 inches in diameter based on an ovendry weight. The sieves, numbers 4, 10, 40, and 200 (USA Standard Series), have openings of 4.76, 2.00, 0.420, and 0.074 millimeters, respectively. Estimates are based on laboratory tests of soils sampled in the survey area and in nearby areas and on estimates made in the field.

Liquid limit and *plasticity index* (Atterberg limits) indicate the plasticity characteristics of a soil. The estimates are based on test data from the survey area or from nearby areas and on field examination.

The estimates of particle-size distribution, liquid limit, and plasticity index are generally rounded to the nearest 5 percent. Thus, if the ranges of gradation and Atterberg limits extend a marginal amount (1 or 2 percentage points) across classification boundaries, the classification in the marginal zone is generally omitted in the table.

Water Management

Table 22 gives information on the soil properties and site features that affect water management. The degree and kind of soil limitations are given for pond reservoir areas; embankments, dikes, and levees; and aquifer-fed excavated ponds. The ratings are both verbal and numerical. Rating class terms indicate the extent to which the soils are limited by all of the soil features that affect these uses. *Not limited* indicates that the soil has features that are very favorable for the specified use. Good performance and very low maintenance can be expected. *Somewhat limited* indicates that the soil has features that are moderately favorable for the specified use. The limitations can be overcome or minimized by special planning, design, or installation. Fair performance and moderate maintenance can be expected. *Very limited* indicates that the soil has one or more features that are unfavorable for the specified use. The limitations generally cannot be overcome without major soil reclamation, special design, or expensive installation procedures. Poor performance and high maintenance can be expected.

Numerical ratings in the tables indicate the severity of individual limitations. The ratings are shown as decimal fractions ranging from 0.01 to 1.00. They indicate gradations between the point at which a soil feature has the greatest negative impact on the use (1.00) and the point at which the soil feature is not a limitation (0.00).

Pond reservoir areas hold water behind a dam or embankment. Soils best suited to this use have low seepage potential in the upper 60 inches. The seepage potential is determined by the permeability of the soil and the depth to fractured bedrock or other permeable material. Excessive slope can affect the storage capacity of the reservoir area.

Embankments, dikes, and levees are raised structures of soil material, generally less than 20 feet high, constructed to impound water or to protect land against overflow. Embankments that have zoned construction (core and shell) are not considered. In this table, the soils are rated as a source of material for embankment fill. The ratings apply to the soil material below the surface layer to a depth of about 5 feet. It is assumed that soil layers will be uniformly mixed and compacted during construction.

The ratings do not indicate the ability of the natural soil to support an embankment. Soil properties to a depth even greater than the height of the embankment can affect performance and safety of the embankment. Generally, deeper onsite investigation is needed to determine these properties.

Soil material in embankments must be resistant to seepage, piping, and erosion

and have favorable compaction characteristics. Unfavorable features include less than 5 feet of suitable material and a high content of stones or boulders, organic matter, or salts or sodium. A high water table affects the amount of usable material. It also affects trafficability.

Aquifer-fed excavated ponds are pits or dugouts that extend to a ground-water aquifer or to a depth below a permanent water table. Excluded are ponds that are fed only by surface runoff and embankment ponds that impound water 3 feet or more above the original surface. Excavated ponds are affected by depth to a permanent water table, permeability of the aquifer, and quality of the water as inferred from the salinity of the soil. Depth to bedrock and the content of large stones affect the ease of excavation.

Physical Properties

Table 23 shows estimates of some physical characteristics and features that affect soil behavior. These estimates are given for the layers of each soil in the survey area. The estimates are based on field observations and on test data for these and similar soils.

Depth to the upper and lower boundaries of each layer is indicated.

Particle size is the effective diameter of a soil particle as measured by sedimentation, sieving, or micrometric methods. Particle sizes are expressed as classes with specific effective diameter class limits. The broad classes are sand, silt, and clay, ranging from the larger to the smaller.

Sand as a soil separate consists of mineral soil particles that are 0.05 millimeter to 2 millimeters in diameter. In table 23, the estimated sand content of each soil layer is given as a percentage, by weight, of the soil material that is less than 2 millimeters in diameter.

Silt as a soil separate consists of mineral soil particles that are 0.002 to 0.05 millimeter in diameter. In table 23, the estimated silt content of each soil layer is given as a percentage, by weight, of the soil material that is less than 2 millimeters in diameter.

Clay as a soil separate consists of mineral soil particles that are less than 0.002 millimeter in diameter. In table 23, the estimated clay content of each soil layer is given as a percentage, by weight, of the soil material that is less than 2 millimeters in diameter.

The content of sand, silt, and clay affects the physical behavior of a soil. Particle size is important for engineering and agronomic interpretations, for determination of soil hydrologic qualities, and for soil classification.

The amount and kind of clay affect the fertility and physical condition of the soil and the ability of the soil to adsorb cations and to retain moisture. They influence shrink-swell potential, permeability, plasticity, the ease of soil dispersion, and other soil properties. The amount and kind of clay in a soil also affect tillage and earthmoving operations.

Moist bulk density is the weight of soil (ovendry) per unit volume. Volume is measured when the soil is at field moisture capacity, that is, the moisture content at $^{1}/_{3}$- or $^{1}/_{10}$-bar (33kPa or 10kPa) moisture tension. Weight is determined after the soil is dried at 105 degrees C. In the table, the estimated moist bulk density of each soil horizon is expressed in grams per cubic centimeter of soil material that is less than 2 millimeters in diameter. Bulk density data are used to compute shrink-swell potential, available water capacity, total pore space, and other soil properties. The moist bulk density of a soil indicates the pore space available for water and roots. Depending on soil texture, a bulk density of more than 1.4 can restrict water storage and root penetration. Moist bulk density is influenced by texture, kind of clay, content of organic matter, and soil structure.

Permeability (K_{sat}) refers to the ability of a soil to transmit water or air. The term "permeability," as used in soil surveys, indicates saturated hydraulic conductivity (K_{sat}). The estimates in the table indicate the rate of water movement, in inches per hour, when the soil is saturated. They are based on soil characteristics observed in the field, particularly structure, porosity, and texture. Permeability is considered in the design of soil drainage systems and septic tank absorption fields.

Available water capacity refers to the quantity of water that the soil is capable of storing for use by plants. The capacity for water storage is given in inches of water per inch of soil for each soil layer. The capacity varies, depending on soil properties that affect retention of water. The most important properties are the content of organic matter, soil texture, bulk density, and soil structure. Available water capacity is an important factor in the choice of plants or crops to be grown and in the design and management of irrigation systems. Available water capacity is not an estimate of the quantity of water actually available to plants at any given time.

Linear extensibility refers to the change in length of an unconfined clod as moisture content is decreased from a moist to a dry state. It is an expression of the volume change between the water content of the clod at $^1/_3$- or $^1/_{10}$-bar tension (33kPa or 10kPa tension) and oven dryness. The volume change is reported in the table as percent change for the whole soil. Volume change is influenced by the amount and type of clay minerals in the soil.

Linear extensibility is used to determine the shrink-swell potential of soils. The shrink-swell potential is low if the soil has a linear extensibility of less than 3 percent; moderate if 3 to 6 percent; high if 6 to 9 percent; and very high if more than 9 percent. If the linear extensibility is more than 3, shrinking and swelling can cause damage to buildings, roads, and other structures and to plant roots. Special design commonly is needed.

Organic matter is the plant and animal residue in the soil at various stages of decomposition. In table 23, the estimated content of organic matter is expressed as a percentage, by weight, of the soil material that is less than 2 millimeters in diameter.

The content of organic matter in a soil can be maintained by returning crop residue to the soil. Organic matter has a positive effect on available water capacity, water infiltration, soil organism activity, and tilth. It is a source of nitrogen and other nutrients for crops and soil organisms.

Erosion factors are shown in table 23 as the K factor (Kw and Kf) and the T factor. Erosion factor K indicates the susceptibility of a soil to sheet and rill erosion by water. Factor K is one of several factors used in the Universal Soil Loss Equation (USLE) and the Revised Universal Soil Loss Equation (RUSLE) to predict the average annual rate of soil loss by sheet and rill erosion in tons per acre per year. The estimates are based primarily on percentage of silt, sand, and organic matter and on soil structure and permeability. Values of K range from 0.02 to 0.69. Other factors being equal, the higher the value, the more susceptible the soil is to sheet and rill erosion by water.

Erosion factor Kw indicates the erodibility of the whole soil. The estimates are modified by the presence of rock fragments.

Erosion factor Kf indicates the erodibility of the fine-earth fraction, or the material less than 2 millimeters in size.

Erosion factor T is an estimate of the maximum average annual rate of soil erosion by wind or water that can occur without affecting crop productivity over a sustained period. The rate is in tons per acre per year.

Wind erodibility groups are made up of soils that have similar properties affecting their susceptibility to wind erosion in cultivated areas. The soils assigned to group 1 are the most susceptible to wind erosion, and those assigned to group 8 are the least susceptible. The groups are as follows:

1. Coarse sands, sands, fine sands, and very fine sands.
2. Loamy coarse sands, loamy sands, loamy fine sands, loamy very fine sands, ash material, and sapric soil material.
3. Coarse sandy loams, sandy loams, fine sandy loams, and very fine sandy loams.

4L. Calcareous loams, silt loams, clay loams, and silty clay loams.

4. Clays, silty clays, noncalcareous clay loams, and silty clay loams that are more than 35 percent clay.
5. Noncalcareous loams and silt loams that are less than 20 percent clay and sandy clay loams, sandy clays, and hemic soil material.
6. Noncalcareous loams and silt loams that are more than 20 percent clay and noncalcareous clay loams that are less than 35 percent clay.
7. Silts, noncalcareous silty clay loams that are less than 35 percent clay, and fibric soil material.
8. Soils that are not subject to wind erosion because of rock fragments on the surface or because of surface wetness.

Wind erodibility index is a numerical value indicating the susceptibility of soil to wind erosion, or the tons per acre per year that can be expected to be lost to wind erosion. There is a close correlation between wind erosion and the texture of the surface layer, the size and durability of surface clods, rock fragments, organic matter, and a calcareous reaction. Soil moisture and frozen soil layers also influence wind erosion.

Table 24 displays estimates of some of the more important values related to soil erodibility. Erosion Factor Kw, Erosion Factor Kf, Erosion Factor T, Wind Erodibility Group, and Wind erodibility Index are shown for each layer of each soil component.

Chemical Properties

Table 25 shows estimates of some chemical characteristics and features that affect soil behavior. These estimates are given for the layers of each soil in the survey area. The estimates are based on field observations and on test data for these and similar soils.

Depth to the upper and lower boundaries of each layer is indicated.

Cation-exchange capacity is the total amount of extractable bases that can be held by the soil, expressed in terms of milliequivalents per 100 grams of soil at neutrality (pH 7.0) or at some other stated pH value. Soils having a low cation-exchange capacity hold fewer cations and may require more frequent applications of fertilizer than soils having a high cation-exchange capacity. The ability to retain cations reduces the hazard of ground-water pollution.

Soil reaction is a measure of acidity or alkalinity. The pH of each soil horizon is based on many field tests. For many soils, values have been verified by laboratory analyses. Soil reaction is important in selecting crops and other plants, in evaluating soil amendments for fertility and stabilization, and in determining the risk of corrosion.

Calcium carbonate equivalent is the percent of carbonates, by weight, in the fraction of the soil less than 2 millimeters in size. The availability of plant nutrients is influenced by the amount of carbonates in the soil. Incorporating nitrogen fertilizer into calcareous soils helps to prevent nitrite accumulation and ammonium-N volatilization.

Gypsum is expressed as a percent, by weight, of hydrated calcium sulfates in the fraction of the soil less than 20 millimeters in size. Gypsum is partially soluble in water. Soils that have a high content of gypsum may collapse if the gypsum is removed by percolating water.

Salinity is a measure of soluble salts in the soil at saturation. It is expressed as the electrical conductivity of the saturation extract, in millimhos per centimeter at 25 degrees C. Estimates are based on field and laboratory measurements at representative sites of nonirrigated soils. The salinity of irrigated soils is affected by the quality of the irrigation water and by the frequency of water application. Hence, the salinity of soils in individual fields can differ greatly from the value given in the table. Salinity affects the suitability of a soil for crop production, the stability of soil if used as construction material, and the potential of the soil to corrode metal and concrete.

Sodium adsorption ratio (SAR) is a measure of the amount of sodium (Na) relative to calcium (Ca) and magnesium (Mg) in the water extract from saturated soil paste. It is the ratio of the Na concentration divided by the square root of one-half of the Ca + Mg concentration. Soils that have SAR values of 13 or more may be characterized by an increased dispersion of organic matter and clay particles, reduced permeability and aeration, and a general degradation of soil structure.

Water Features

Table 26 gives estimates of various water features. The estimates are used in land use planning that involves engineering considerations.

Hydrologic soil groups are based on estimates of runoff potential. Soils are assigned to one of four groups according to the rate of water infiltration when the soils are not protected by vegetation, are thoroughly wet, and receive precipitation from long-duration storms.

The four hydrologic soil groups are:

Group A. Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist mainly of deep, well drained to excessively drained sands or gravelly sands. These soils have a high rate of water transmission.

Group B. Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

Group C. Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils having a layer that impedes the downward movement of water or soils of moderately fine texture or fine texture. These soils have a slow rate of water transmission.

Group D. Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clays that have a high shrink-swell potential, soils that have a high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

If a soil is assigned to a dual hydrologic group (A/D, B/D, or C/D), the first letter is for drained areas and the second is for undrained areas.

The *months* in the table indicate the portion of the year in which the feature is most likely to be a concern.

Water table refers to a saturated zone in the soil. Table 26 indicates, by month, depth to the top *(upper limit)* and base *(lower limit)* of the saturated zone in most years. Estimates of the upper and lower limits are based mainly on observations of the water table at selected sites and on evidence of a saturated zone, namely grayish colors or mottles (redoximorphic features) in the soil. A saturated zone that lasts for less than a month is not considered a water table.

Ponding is standing water in a closed depression. Unless a drainage system is installed, the water is removed only by percolation, transpiration, or evaporation. Table 26 indicates *surface water depth* and the *duration* and *frequency* of ponding.

Duration is expressed as *very brief* if less than 2 days, *brief* if 2 to 7 days, *long* if 7 to 30 days, and *very long* if more than 30 days. Frequency is expressed as none, rare, occasional, and frequent. *None* means that ponding is not probable; *rare* that it is unlikely but possible under unusual weather conditions (the chance of ponding is nearly 0 percent to 5 percent in any year); *occasional* that it occurs, on the average, once or less in 2 years (the chance of ponding is 5 to 50 percent in any year); and *frequent* that it occurs, on the average, more than once in 2 years (the chance of ponding is more than 50 percent in any year).

Flooding is the temporary inundation of an area caused by overflowing streams, by runoff from adjacent slopes, or by tides. Water standing for short periods after rainfall or snowmelt is not considered flooding, and water standing in swamps and marshes is considered ponding rather than flooding.

Duration and *frequency* are estimated. Duration is expressed as *extremely brief* if 0.1 hour to 4 hours, *very brief* if 4 hours to 2 days, *brief* if 2 to 7 days, *long* if 7 to 30 days, and *very long* if more than 30 days. Frequency is expressed as none, very rare, rare, occasional, frequent, and very frequent. *None* means that flooding is not probable; *very rare* that it is very unlikely but possible under extremely unusual weather conditions (the chance of flooding is less than 1 percent in any year); *rare* that it is unlikely but possible under unusual weather conditions (the chance of flooding is 1 to 5 percent in any year); *occasional* that it occurs infrequently under normal weather conditions (the chance of flooding is 5 to 50 percent in any year); *frequent* that it is likely to occur often under normal weather conditions (the chance of flooding is more than 50 percent in any year but is less than 50 percent in all months in any year); and *very frequent* that it is likely to occur very often under normal weather conditions (the chance of flooding is more than 50 percent in all months of any year).

The information is based on evidence in the soil profile, namely thin strata of gravel, sand, silt, or clay deposited by floodwater; irregular decrease in organic matter content with increasing depth; and little or no horizon development.

Also considered are local information about the extent and levels of flooding and the relation of each soil on the landscape to historic floods. Information on the extent of flooding based on soil data is less specific than that provided by detailed engineering surveys that delineate flood-prone areas at specific flood frequency levels.

Soil Features

Table 27 gives estimates of various soil features. The estimates are used in land use planning that involves engineering considerations.

A *restrictive layer* is a nearly continuous layer that has one or more physical, chemical, or thermal properties that significantly impede the movement of water and air through the soil or that restrict roots or otherwise provide an unfavorable root environment. Examples are bedrock, cemented layers, dense layers, and frozen layers. The table indicates the hardness and thickness of the restrictive layer, both of which significantly affect the ease of excavation. *Depth to top* is the vertical distance from the soil surface to the upper boundary of the restrictive layer.

Subsidence is the settlement of organic soils or of saturated mineral soils of very low density. Subsidence generally results from either desiccation and shrinkage or oxidation of organic material, or both, following drainage. Subsidence takes place gradually, usually over a period of several years. The table shows the expected initial subsidence, which usually is a result of drainage, and total subsidence, which results from a combination of factors.

Potential for frost action is the likelihood of upward or lateral expansion of the soil caused by the formation of segregated ice lenses (frost heave) and the subsequent

collapse of the soil and loss of strength on thawing. Frost action occurs when moisture moves into the freezing zone of the soil. Temperature, texture, density, permeability, content of organic matter, and depth to the water table are the most important factors considered in evaluating the potential for frost action. It is assumed that the soil is not insulated by vegetation or snow and is not artificially drained. Silty and highly structured, clayey soils that have a high water table in winter are the most susceptible to frost action. Well drained, very gravelly, or very sandy soils are the least susceptible. Frost heave and low soil strength during thawing cause damage to pavements and other rigid structures.

Risk of corrosion pertains to potential soil-induced electrochemical or chemical action that corrodes or weakens uncoated steel or concrete. The rate of corrosion of uncoated steel is related to such factors as soil moisture, particle-size distribution, acidity, and electrical conductivity of the soil. The rate of corrosion of concrete is based mainly on the sulfate and sodium content, texture, moisture content, and acidity of the soil. Special site examination and design may be needed if the combination of factors results in a severe hazard of corrosion. The steel or concrete in installations that intersect soil boundaries or soil layers is more susceptible to corrosion than the steel or concrete in installations that are entirely within one kind of soil or within one soil layer.

For uncoated steel, the risk of corrosion, expressed as *low, moderate,* or *high,* is based on soil drainage class, total acidity, electrical resistivity near field capacity, and electrical conductivity of the saturation extract.

For concrete, the risk of corrosion also is expressed as *low, moderate,* or *high*. It is based on soil texture, acidity, and amount of sulfates in the saturation extract.

Table 28 shows those map unit characteristics related to soil development or pedogenesis – the climate, landscape, parent material, and vegetation. For each soil, the table shows percent of map unit (component composition), slope (range), elevation (range), MAP (mean annual precipitation range), landform, geology, parent material, and ecological site.

Formation of the Soils

The term “soil formation” refers to two processes that occur simultaneously in the environment. The first is the breakdown, through physical and chemical weathering, of consolidated material that is not capable of sustaining plants (rock) to a loose material that is capable of sustaining plant life (soil). The second process is the subsequent development of soil horizons within the unconsolidated material; this process is called pedogenesis.

Five major factors are recognized as working in concert to influence soil formation: parent material, climate, topography, biological factors, and time (Brady, 2002). The interactions of these five factors result in the wide variety of soils found throughout the world, as well as in any specific study area, such as Natural Bridges National Monument.

Parent material

Parent material is the unconsolidated material from which soils develop, through chemical and physical weathering processes. The inherent properties of the parent material profoundly affect the soils that subsequently develop. In general, the more arid the climate, the more influence parent material has on soils. In the Monument, there are three distinct parent materials involved in the soil formation process: eolian material, alluvium, and colluvium.

All of the soils mapped within the Monument form in materials that have moved into place from elsewhere. These materials may have traveled many hundreds of miles or only a few feet. One of the major parent materials of soils in Natural Bridges is eolian, or wind-blown, material. This material is composed primarily of fine and very fine sand, and to a lesser degree, silt. The eolian soils which develop from this material are the result of episodic deposition over a long period of time; some nearby samples in Canyonlands National Park have been dated to 46,000 years ago, with depositional events continuing up to the present day in varying degrees of intensity (Reynolds et al., 2006). The eolian soils have characteristics that reflect their origins; most are reddish brown and yellowish red in color, have loamy textures, and have very few coarse fragments within the soil profile. These eolian soils dominate the mesa top in the Monument; varying in depth from a few inches to many feet, they blanket the underlying Cedar Mesa Sandstone.

The second parent material found within the Monument is alluvium, or water-deposited material. These soils are found in the bottoms of canyons within Natural Bridges National Monument. Sediments along waterways such as these canyon bottoms have different textures, depending on whether the water moves quickly or slowly. Fast-moving water leaves gravel, rocks, and sand. Slow-moving water leaves fine textured material (clay and silt) when sediments in the water settle out. All of these materials are found in the Monument’s canyons. Most of the floodplain and terrace soils in the canyons are comprised of various sand layers, and some silt layers are present as well. Water-borne gravels, cobbles, and stones can be seen

throughout the canyons, testament to the occasional torrents that rage through the narrow waterways.

The third parent material is colluvium, or material transported by gravity. In the Monument, colluvium is found on talus slopes and escarpments. Cedar Mesa Sandstone is the source for the colluvial deposits in the canyons, and Organ Rock Sandstone is the source material along the Red House Cliffs in the western section of the survey area. The soils that develop from the Cedar Mesa Sandstone colluvium reflect the characteristics of the parent material; they have many rocks throughout the profiles and on the surface ranging from gravels to boulders, and the textures are sandy. The soils developed from the Organ Rock Sandstone have similar amounts of rock fragments, but a loamier texture, reflecting the differences in the sandstone formation sources.

Climate

Soils vary, depending on the climate. Temperature and moisture cause different patterns of weathering and leaching. Wind redistributes sand and other particles, especially in arid regions. The amount, intensity, timing, and kind of precipitation influence soil formation. Seasonal and daily changes in temperature affect moisture effectiveness, biological activity, rates of chemical reactions, and kinds of vegetation (USDA, Soil Formation and Classification, 2009).

At Natural Bridges National Monument, the annual mean precipitation is approximately 12.5 inches, but the annual precipitation can range from 6 to 19 inches. Much of the rainfall occurs as convective storms in late summer; about 20 to 35 percent of the total precipitation falls in July and August. About 15 to 25 percent of the precipitation is snow. Snowpacks are generally light and not persistent throughout the winter, except at the higher elevations. The average annual air temperature ranges from 37 to 63 degrees F. The frost-free (<32°F) period averages 140 days and ranges from 120 to 170 days. The soil temperature regime is mesic, and the soil moisture regime is aridic ustic.

The cool temperatures and short frost-free period in the Monument affect soil development. In areas of the world that are warmer and wetter, biochemical reactions, chemical weathering, plant growth and decomposition, and other factors that affect soil development are accelerated. Cooler, drier climates, such as that of the Monument, result in soils that have comparatively less soil development, or pedogenesis.

The Monument’s relatively low rate of precipitation is also reflected in the degree of soil development. The amount of precipitation is sufficient to facilitate translocation of materials through the soil profile, such as salts and clays. These materials collect at the approximate wetting front in the soil profile, or the depth to which soil moisture generally penetrates each year. Consequently, we can observe calcic horizons in some soils; these horizons are zones of calcium carbonate accumulation, characterized by lighter color and a strong reaction to cold dilute hydrochloric acid. Calcic horizon designations contain the letter “k” in them, such as Bk (the Plumasano soil is an example). In an area with higher precipitation, this calcic layer would be pushed deeper down through the soil; in very high precipitation zones, all carbonates and other salts would be leached completely from the profile.

Precipitation also greatly influences weathering and translocation of clays downward through the soil profile. Some of the deeper soils in the Monument have a zone of clay accumulation in an argillic horizon, denoted by the letter “t” in the horizon designation, such as Bt or Btk (the Nomrah soil is an example). Argillics have heavier textures than the horizons above or below them. Cambic horizons, denoted by the horizon designation Bw, are also zones of some pedogenic activity, such as development of structure and/or alteration of color, but no significant accumulation of carbonates or clay.

Topography

Slope and aspect affect the moisture and temperature of soil. Steep slopes facing the sun are warmer, similar to the south-facing side of a house. Steep soils may be eroded and lose their topsoil as they form. Thus, they may be thinner than the more nearly level soils that receive deposits from areas upslope.

In Natural Bridges, the effects of topography on soil development may be seen in a comparison of steeper slopes with areas of more gentle slopes. On the mesa top, there are areas of steeper slopes where erosion has removed the top layers of the soil, revealing the subsurface horizons. The whitish calcic horizons are particularly evident in these areas of “breaks,” seen in the Tanoan family soils of map unit 70. Steep areas such as these often lack an A horizon, or surface zones of structure and organic matter accumulation; topography plays a role in this, as erosion and gravity continually remove the top layers of the soil.

Biological factors

Plants, animals, micro-organisms, and humans affect soil formation. Animals and micro-organisms mix soils and form burrows and pores. Plant roots open channels in the soils. Different types of roots have different effects on soils. Grass roots are “fibrous” near the soil surface and easily decompose, adding organic matter. Taproots open pathways through dense layers. Micro-organisms affect chemical exchanges between roots and soil. Humans can mix the soil so extensively that the soil material is again considered parent.

The native vegetation depends on climate, topography, and biological factors, plus many soil factors such as soil density, depth, chemistry, temperature, and moisture. Leaves from plants fall to the surface and decompose on the soil. Organisms decompose these leaves and mix them with the upper part of the soil. Trees and shrubs have large roots which may grow to considerable depths.

Time

Soil formation processes are continuous, and over time, soils exhibit the features that reflect the other soil-forming factors. Recently deposited material, such as the deposition from a flood, exhibits no features from soil development activities. The previous soil surface and underlying horizons become buried. The time clock resets for these soils. Terraces above the active floodplain, while genetically similar to the floodplain, are older land surfaces and exhibit more development features.

These soil forming factors continue to affect soils even on “stable” landscapes. Materials are deposited on their surface, and materials are blown or washed away from the surface. Additions, removals, and alterations are slow or rapid, depending on climate, landscape position, and biological activity. As a result of this ongoing process of soil movement, some soils have no recognizable “A” horizon, which is normally a zone of some organic matter accumulation and some structure development.

Areas which are more susceptible to surface removal include those areas that have relatively less microbiotic crust or a higher degree of slope. Many “stable” areas, such as those with lower slopes, have well-developed subsurface horizons, such as calcic, argillic, or cambic horizons. Soils in these relatively stable areas that do not undergo the continuous erosion caused by steeper slopes have the time required to develop these subsurface horizons.

Soils in less stable areas often have horizons closely reflective of the original parent material; these horizons are designated with a “C.” The Metuck soil is an example. Soils in areas of steep colluvial slopes are susceptible to movement downslope by gravity and water; this frequent movement of the soil material impedes pedogenic development. Pedogenesis, or subsurface horizon development, requires time in place.

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Glossary

Aeration, soil. The exchange of air in soil with air from the atmosphere. The air in a well aerated soil is similar to that in the atmosphere; the air in a poorly aerated soil is considerably higher in carbon dioxide and lower in oxygen.

Aggregate, soil. Many fine particles held in a single mass or cluster. Natural soil aggregates, such as granules, blocks, or prisms, are called peds. Clods are aggregates produced by tillage or logging.

Alkali (sodic) soil. A soil having so high a degree of alkalinity (pH 8.5 or higher) or so high a percentage of exchangeable sodium (15 percent or more of the total exchangeable bases), or both, that plant growth is restricted.

Alluvial fan. The fanlike deposit of a stream where it issues from a gorge upon a plain or of a tributary stream near or at its junction with its main stream.

Alluvium. Material, such as sand, silt, or clay, deposited on land by streams.

Aquic conditions. Current soil wetness characterized by saturation, reduction, and redoximorphic features.

Argillic horizon. A subsoil horizon characterized by an accumulation of illuvial clay.

Aspect. The direction in which a slope faces.

Association, soil. A group of soils or miscellaneous areas geographically associated in a characteristic repeating pattern and defined and delineated as a single map unit.

Available water capacity (available moisture capacity). The capacity of soils to hold water available for use by most plants. It is commonly defined as the difference between the amount of soil water at field moisture capacity and the amount at wilting point. It is commonly expressed as inches of water per inch of soil. The capacity, in inches, in a 60-inch profile or to a limiting layer is expressed as:

Very low	0 to 3
Low	3 to 6
Moderate	6 to 9
High	9 to 12
Very high	more than 12

Backslope. The position that forms the steepest and generally linear, middle portion of a hillslope. In profile, backslopes are commonly bounded by a convex shoulder above and a concave footslope below.

Badland. Steep or very steep, commonly nonstony, barren land dissected by many intermittent drainage channels. Badland is most common in semiarid and arid regions where streams are entrenched in soft geologic material. Local relief generally ranges from 25 to 500 feet. Runoff potential is very high, and geologic erosion is active.

Basal area. The area of a cross section of a tree, generally referring to the section at breast height and measured outside the bark. It is a measure of stand density, commonly expressed in square feet.

Base saturation. The degree to which material having cation-exchange properties is

saturated with exchangeable bases (sum of Ca, Mg, Na, and K), expressed as a percentage of the total cation-exchange capacity.

Bedding planes. Fine strata, less than 5 millimeters thick, in unconsolidated alluvial, eolian, lacustrine, or marine sediment.

Bedrock. The solid rock that underlies the soil and other unconsolidated material or that is exposed at the surface.

Bedrock-controlled topography. A landscape where the configuration and relief of the landforms are determined or strongly influenced by the underlying bedrock.

Bisequum. Two sequences of soil horizons, each of which consists of an illuvial horizon and the overlying eluvial horizons.

Blowout. A shallow depression from which all or most of the soil material has been removed by the wind. A blowout has a flat or irregular floor formed by a resistant layer or by an accumulation of pebbles or cobbles. In some blowouts the water table is exposed.

Boulders. Rock fragments larger than 2 feet (60 centimeters) in diameter.

Breaks. The steep and very steep broken land at the border of an upland summit that is dissected by ravines.

Breast height. An average height of 4.5 feet above the ground surface; the point on a tree where diameter measurements are ordinarily taken.

Butte. An isolated small mountain or hill with steep or precipitous sides and a top variously flat, rounded, or pointed that may be a residual mass isolated by erosion or an exposed volcanic neck.

Calcareous soil. A soil containing enough calcium carbonate (commonly combined with magnesium carbonate) to effervesce visibly when treated with cold, dilute hydrochloric acid.

Canopy. The leafy crown of trees or shrubs. (See Crown.)

Canyon. A long, deep, narrow, very steep sided valley with high, precipitous walls in an area of high local relief.

Capillary water. Water held as a film around soil particles and in tiny spaces between particles. Surface tension is the adhesive force that holds capillary water in the soil.

Catena. A sequence, or “chain,” of soils on a landscape that formed in similar kinds of parent material but have different characteristics as a result of differences in relief and drainage.

Cation. An ion carrying a positive charge of electricity. The common soil cations are calcium, potassium, magnesium, sodium, and hydrogen.

Cation-exchange capacity. The total amount of exchangeable cations that can be held by the soil, expressed in terms of milliequivalents per 100 grams of soil at neutrality (pH 7.0) or at some other stated pH value. The term, as applied to soils, is synonymous with base-exchange capacity but is more precise in meaning.

Channery soil material. Soil material that has, by volume, 15 to 35 percent thin, flat fragments of sandstone, shale, slate, limestone, or schist as much as 6 inches (15 centimeters) along the longest axis. A single piece is called a channer.

Clay. As a soil separate, the mineral soil particles less than 0.002 millimeter in diameter. As a soil textural class, soil material that is 40 percent or more clay, less than 45 percent sand, and less than 40 percent silt.

Clay film. A thin coating of oriented clay on the surface of a soil aggregate or lining pores or root channels. Synonyms: clay coating, clay skin.

Claypan. A slowly permeable soil horizon that contains much more clay than the horizons above it. A claypan is commonly hard when dry and plastic or stiff when wet.

Climax plant community. The stabilized plant community on a particular site. The

plant cover reproduces itself and does not change so long as the environment remains the same.

Coarse textured soil. Sand or loamy sand.

Cobble (or cobblestone). A rounded or partly rounded fragment of rock 3 to 10 inches (7.6 to 25 centimeters) in diameter.

Cobbly soil material. Material that has 15 to 35 percent, by volume, rounded or partially rounded rock fragments 3 to 10 inches (7.6 to 25 centimeters) in diameter. Very cobbly soil material has 35 to 60 percent of these rock fragments, and extremely cobbly soil material has more than 60 percent.

COLE (coefficient of linear extensibility). See Linear extensibility.

Colluvium. Soil material or rock fragments, or both, moved by creep, slide, or local wash and deposited at the base of steep slopes.

Complex, soil. A map unit of two or more kinds of soil or miscellaneous areas in such an intricate pattern or so small in area that it is not practical to map them separately at the selected scale of mapping. The pattern and proportion of the soils or miscellaneous areas are somewhat similar in all areas.

Concretions. Cemented bodies with crude internal symmetry organized around a point, a line, or a plane. They typically take the form of concentric layers visible to the naked eye. Calcium carbonate, iron oxide, and manganese oxide are common compounds making up concretions. If formed in place, concretions of iron oxide or manganese oxide are generally considered a type of redoximorphic concentration.

Conglomerate. A coarse grained, clastic rock composed of rounded or subangular rock fragments more than 2 millimeters in diameter. It commonly has a matrix of sand and finer textured material. Conglomerate is the consolidated equivalent of gravel.

Consistence, soil. Refers to the degree of cohesion and adhesion of soil material and its resistance to deformation when ruptured. Consistence includes resistance of soil material to rupture and to penetration; plasticity, toughness, and stickiness of puddled soil material; and the manner in which the soil material behaves when subject to compression. Terms describing consistence are defined in the “Soil Survey Manual.”

Control section. The part of the soil on which classification is based. The thickness varies among different kinds of soil, but for many it is that part of the soil profile between depths of 10 inches and 40 or 80 inches.

Coppice dune. A small dune of fine grained soil material stabilized around shrubs or small trees.

Corrosion. Soil-induced electrochemical or chemical action that dissolves or weakens concrete or uncoated steel.

Crown. The upper part of a tree or shrub, including the living branches and their foliage.

Culmination of the mean annual increment (CMAI). The average annual increase per acre in the volume of a stand. Computed by dividing the total volume of the stand by its age. As the stand increases in age, the mean annual increment continues to increase until mortality begins to reduce the rate of increase. The point where the stand reaches its maximum annual rate of growth is called the culmination of the mean annual increment.

Cutbanks cave (in tables). The walls of excavations tend to cave in or slough.

Decreasers. The most heavily grazed climax range plants. Because they are the most palatable, they are the first to be destroyed by overgrazing.

Dense layer (in tables). A very firm, massive layer that has a bulk density of more than 1.8 grams per cubic centimeter. Such a layer affects the ease of digging and can affect filling and compacting.

Depth, soil. Generally, the thickness of the soil over bedrock. Very deep soils are more than 60 inches deep over bedrock; deep soils, 40 to 60 inches; moderately deep, 20 to 40 inches; shallow, 10 to 20 inches; and very shallow, less than 10 inches.

Desert pavement. On a desert surface, a layer of gravel or larger fragments that was emplaced by upward movement of the underlying sediments or that remains after finer particles have been removed by running water or the wind.

Dip slope. A slope of the land surface, roughly determined by and approximately conforming to the dip of the underlying bedrock.

Drainage class (natural). Refers to the frequency and duration of wet periods under conditions similar to those under which the soil formed. Alterations of the water regime by human activities, either through drainage or irrigation, are not a consideration unless they have significantly changed the morphology of the soil. Seven classes of natural soil drainage are recognized—excessively drained, somewhat excessively drained, well drained, moderately well drained, somewhat poorly drained, poorly drained, and very poorly drained. These classes are defined in the “Soil Survey Manual.”

Drainage, surface. Runoff, or surface flow of water, from an area.

Duff. A generally firm organic layer on the surface of mineral soils. It consists of fallen plant material that is in the process of decomposition and includes everything from the litter on the surface to underlying pure humus.

Ecological site. An area where climate, soil, and relief are sufficiently uniform to produce a distinct natural plant community. An ecological site is the product of all the environmental factors responsible for its development. It is typified by an association of species that differ from those on other ecological sites in kind and/or proportion of species or in total production.

Eluviation. The movement of material in true solution or colloidal suspension from one place to another within the soil. Soil horizons that have lost material through eluviation are eluvial; those that have received material are illuvial.

Endosaturation. A type of saturation of the soil in which all horizons between the upper boundary of saturation and a depth of 2 meters are saturated.

Eolian soil material. Earthy parent material accumulated through wind action; commonly refers to sandy material in dunes or to loess in blankets on the surface.

Ephemeral stream. A stream, or reach of a stream, that flows only in direct response to precipitation. It receives no long-continued supply from melting snow or other source, and its channel is above the water table at all times.

Episaturation. A type of saturation indicating a perched water table in a soil in which saturated layers are underlain by one or more unsaturated layers within 2 meters of the surface.

Erosion. The wearing away of the land surface by water, wind, ice, or other geologic agents and by such processes as gravitational creep.

Erosion (geologic). Erosion caused by geologic processes acting over long geologic periods and resulting in the wearing away of mountains and the building up of such landscape features as flood plains and coastal plains. Synonym: natural erosion.

Erosion (accelerated). Erosion much more rapid than geologic erosion, mainly as a result of human or animal activities or of a catastrophe in nature, such as a fire, that exposes the surface.

Erosion pavement. A layer of gravel or stones that remains on the surface after fine particles are removed by sheet or rill erosion.

Escarpment. A relatively continuous and steep slope or cliff breaking the general continuity of more gently sloping land surfaces and resulting from erosion or faulting. Synonym: scarp.

Extrusive rock. Igneous rock derived from deep-seated molten matter (magma) emplaced on the earth's surface.

Fertility, soil. The quality that enables a soil to provide plant nutrients, in adequate amounts and in proper balance, for the growth of specified plants when light, moisture, temperature, tilth, and other growth factors are favorable.

Field moisture capacity. The moisture content of a soil, expressed as a percentage of the ovendry weight, after the gravitational, or free, water has drained away; the field moisture content 2 or 3 days after a soaking rain; also called normal field capacity, normal moisture capacity, or capillary capacity.

Fine textured soil. Sandy clay, silty clay, or clay.

Flaggy soil material. Material that has, by volume, 15 to 35 percent flagstones. Very flaggy soil material has 35 to 60 percent flagstones, and extremely flaggy soil material has more than 60 percent flagstones.

Flagstone. A thin fragment of sandstone, limestone, slate, shale, or (rarely) schist 6 to 15 inches (15 to 38 centimeters) long.

Flood plain. A nearly level alluvial plain that borders a stream and is subject to flooding unless protected artificially.

Fluvial. Of or pertaining to rivers; produced by river action, as a fluvial plain.

Foothill. A steeply sloping upland that has relief of as much as 1,000 feet (300 meters) and fringes a mountain range or high-plateau escarpment.

Footslope. The position that forms the inner, gently inclined surface at the base of a hillslope. In profile, footslopes are commonly concave. A footslope is a transition zone between upslope sites of erosion and transport (shoulders and backslopes) and downslope sites of deposition (toeslopes).

Forb. Any herbaceous plant not a grass or a sedge.

Forest cover. All trees and other woody plants (underbrush) covering the ground in a forest.

Forest type. A stand of trees similar in composition and development because of given physical and biological factors by which it may be differentiated from other stands.

Genesis, soil. The mode of origin of the soil. Refers especially to the processes or soil-forming factors responsible for the formation of the solum, or true soil, from the unconsolidated parent material.

Gravel. Rounded or angular fragments of rock as much as 3 inches (2 millimeters to 7.6 centimeters) in diameter. An individual piece is a pebble.

Gravelly soil material. Material that has 15 to 35 percent, by volume, rounded or angular rock fragments, not prominently flattened, as much as 3 inches (7.6 centimeters) in diameter.

Ground water. Water filling all the unblocked pores of the material below the water table.

Gully. A miniature valley with steep sides cut by running water and through which water ordinarily runs only after rainfall. The distinction between a gully and a rill is one of depth. A gully generally is an obstacle to farm machinery and is too deep to be obliterated by ordinary tillage; a rill is of lesser depth and can be smoothed over by ordinary tillage.

Hard bedrock. Bedrock that cannot be excavated except by blasting or by the use of special equipment that is not commonly used in construction.

Hardpan. A hardened or cemented soil horizon, or layer. The soil material is sandy, loamy, or clayey and is cemented by iron oxide, silica, calcium carbonate, or other substance.

Hard to reclaim (in tables). Reclamation is difficult after the removal of soil for construction and other uses. Revegetation and erosion control are extremely difficult.

Head out. To form a flower head.

Head slope. A geomorphic component of hills consisting of a laterally concave area of a hillside, especially at the head of a drainageway. The overland waterflow is converging.

Hill. A natural elevation of the land surface, rising as much as 1,000 feet above surrounding lowlands, commonly of limited summit area and having a well defined outline; hillsides generally have slopes of more than 15 percent. The distinction between a hill and a mountain is arbitrary and is dependent on local usage.

Horizon, soil. A layer of soil, approximately parallel to the surface, having distinct characteristics produced by soil-forming processes. In the identification of soil horizons, an uppercase letter represents the major horizons. Numbers or lowercase letters that follow represent subdivisions of the major horizons. An explanation of the subdivisions is given in the “Soil Survey Manual.” The major horizons of mineral soil are as follows:

O horizon. — An organic layer of fresh and decaying plant residue.

A horizon. — The mineral horizon at or near the surface in which an accumulation of humified organic matter is mixed with the mineral material. Also, a plowed surface horizon, most of which was originally part of a B horizon.

E horizon. — The mineral horizon in which the main feature is loss of silicate clay, iron, aluminum, or some combination of these.

B horizon. — The mineral horizon below an A horizon. The B horizon is in part a layer of transition from the overlying A to the underlying C horizon. The B horizon also has distinctive characteristics, such as (1) accumulation of clay, sesquioxides, humus, or a combination of these; (2) prismatic or blocky structure; (3) redder or browner colors than those in the A horizon; or (4) a combination of these.

C horizon. — The mineral horizon or layer, excluding indurated bedrock, that is little affected by soil-forming processes and does not have the properties typical of the overlying soil material. The material of a C horizon may be either like or unlike that in which the solum formed. If the material is known to differ from that in the solum, an Arabic numeral, commonly a 2, precedes the letter C.

Cr horizon.— Soft, consolidated bedrock beneath the soil.

R layer. — Consolidated bedrock beneath the soil. The bedrock commonly underlies a C horizon, but it can be directly below an A or a B horizon.

Humus. The well decomposed, more or less stable part of the organic matter in mineral soils.

Hydrologic soil groups. Refers to soils grouped according to their runoff potential. The soil properties that influence this potential are those that affect the minimum rate of water infiltration on a bare soil during periods after prolonged wetting when the soil is not frozen. These properties are depth to a seasonal high water table, the infiltration rate and permeability after prolonged wetting, and depth to a very slowly permeable layer. The slope and the kind of plant cover are not considered but are separate factors in predicting runoff.

Igneous rock. Rock formed by solidification from a molten or partially molten state. Major varieties include plutonic and volcanic rock. Examples are andesite, basalt, and granite.

Illuviation. The movement of soil material from one horizon to another in the soil profile. Generally, material is removed from an upper horizon and deposited in a lower horizon.

Impervious soil. A soil through which water, air, or roots penetrate slowly or not at all. No soil is absolutely impervious to air and water all the time.

Increasers. Species in the climax vegetation that increase in amount as the more

desirable plants are reduced by close grazing. Increasers commonly are the shorter plants and the less palatable to livestock.

Interfluve. An elevated area between two drainageways that sheds water to those drainageways.

Intermittent stream. A stream, or reach of a stream, that flows for prolonged periods only when it receives ground-water discharge or long, continued contributions from melting snow or other surface and shallow subsurface sources.

Invaders. On range, plants that encroach into an area and grow after the climax vegetation has been reduced by grazing. Generally, plants invade following disturbance of the surface.

Iron depletions. Low-chroma zones having a low content of iron and manganese oxide because of chemical reduction and removal, but having a clay content similar to that of the adjacent matrix. A type of redoximorphic depletion.

Knoll. A small, low, rounded hill rising above adjacent landforms.

K_{sat}. Saturated hydraulic conductivity. (See Permeability.)

Lacustrine deposit. Material deposited in lake water and exposed when the water level is lowered or the elevation of the land is raised.

Landslide. The rapid downhill movement of a mass of soil and loose rock, generally when wet or saturated. The speed and distance of movement, as well as the amount of soil and rock material, vary greatly.

Large stones (in tables). Rock fragments 3 inches (7.6 centimeters) or more across. Large stones adversely affect the specified use of the soil.

Leaching. The removal of soluble material from soil or other material by percolating water.

Linear extensibility. Refers to the change in length of an unconfined clod as moisture content is decreased from a moist to a dry state. Linear extensibility is used to determine the shrink-swell potential of soils. It is an expression of the volume change between the water content of the clod at $^1/_3$- or $^1/_{10}$-bar tension (33kPa or 10kPa tension) and oven dryness. Volume change is influenced by the amount and type of clay minerals in the soil. The volume change is the percent change for the whole soil. If it is expressed as a fraction, the resulting value is COLE, coefficient of linear extensibility.

Liquid limit. The moisture content at which the soil passes from a plastic to a liquid state.

Loam. Soil material that is 7 to 27 percent clay particles, 28 to 50 percent silt particles, and less than 52 percent sand particles.

Loess. Fine grained material, dominantly of silt-sized particles, deposited by wind.

Low strength. The soil is not strong enough to support loads.

Masses. Concentrations of substances in the soil matrix that do not have a clearly defined boundary with the surrounding soil material and cannot be removed as a discrete unit. Common compounds making up masses are calcium carbonate, gypsum or other soluble salts, iron oxide, and manganese oxide. Masses consisting of iron oxide or manganese oxide generally are considered a type of redoximorphic concentration.

Medium textured soil. Very fine sandy loam, loam, silt loam, or silt.

Mesa. A broad, nearly flat topped and commonly isolated upland mass characterized by summit widths that are more than the heights of bounding erosional scarps.

Metamorphic rock. Rock of any origin altered in mineralogical composition, chemical composition, or structure by heat, pressure, and movement. Nearly all such rocks are crystalline.

Mineral soil. Soil that is mainly mineral material and low in organic material. Its bulk density is more than that of organic soil.

Miscellaneous area. An area that has little or no natural soil and supports little or no vegetation.

Moderately coarse textured soil. Coarse sandy loam, sandy loam, or fine sandy loam.

Moderately fine textured soil. Clay loam, sandy clay loam, or silty clay loam.

Morphology, soil. The physical makeup of the soil, including the texture, structure, porosity, consistence, color, and other physical, mineral, and biological properties of the various horizons, and the thickness and arrangement of those horizons in the soil profile.

Mottling, soil. Irregular spots of different colors that vary in number and size. Descriptive terms are as follows: abundance—few, common, and many; size—fine, medium, and coarse; and contrast—faint, distinct, and prominent. The size measurements are of the diameter along the greatest dimension. Fine indicates less than 5 millimeters (about 0.2 inch); medium, from 5 to 15 millimeters (about 0.2 to 0.6 inch); and coarse, more than 15 millimeters (about 0.6 inch).

Mountain. A natural elevation of the land surface, rising more than 1,000 feet above surrounding lowlands, commonly of restricted summit area (relative to a plateau) and generally having steep sides. A mountain can occur as a single, isolated mass or in a group forming a chain or range.

Mudstone. Sedimentary rock formed by induration of silt and clay in approximately equal amounts.

Munsell notation. A designation of color by degrees of three simple variables—hue, value, and chroma. For example, a notation of 10YR 6/4 is a color with hue of 10YR, value of 6, and chroma of 4.

Natric horizon. A special kind of argillic horizon that contains enough exchangeable sodium to have an adverse effect on the physical condition of the subsoil.

Neutral soil. A soil having a pH value of 6.6 to 7.3. (See Reaction, soil.)

Nodules. Cemented bodies lacking visible internal structure. Calcium carbonate, iron oxide, and manganese oxide are common compounds making up nodules. If formed in place, nodules of iron oxide or manganese oxide are considered types of redoximorphic concentrations.

Nose slope. A geomorphic component of hills consisting of the projecting end (laterally convex area) of a hillside. The overland waterflow is predominantly divergent.

Nutrient, plant. Any element taken in by a plant essential to its growth. Plant nutrients are mainly nitrogen, phosphorus, potassium, calcium, magnesium, sulfur, iron, manganese, copper, boron, and zinc obtained from the soil and carbon, hydrogen, and oxygen obtained from the air and water.

Organic matter. Plant and animal residue in the soil in various stages of decomposition. The content of organic matter in the surface layer is described as follows:

Very low	less than 0.5 percent
Low	0.5 to 1.0 percent
Moderately low	1.0 to 2.0 percent
Moderate	2.0 to 4.0 percent
High	4.0 to 8.0 percent
Very high	more than 8.0 percent

Pan. A compact, dense layer in a soil that impedes the movement of water and the growth of roots. For example, hardpan, fragipan, claypan, plowpan, and traffic pan.

Parent material. The unconsolidated organic and mineral material in which soil forms.

Ped. An individual natural soil aggregate, such as a granule, a prism, or a block.

Pedon. The smallest volume that can be called “a soil.” A pedon is three dimensional and large enough to permit study of all horizons. Its area ranges from about 10 to 100 square feet (1 square meter to 10 square meters), depending on the variability of the soil.

Percolation. The movement of water through the soil.

Permeability. The quality of the soil that enables water or air to move downward through the profile. The rate at which a saturated soil transmits water is accepted as a measure of this quality. In soil physics, the rate is referred to as “saturated hydraulic conductivity,” which is defined in the “Soil Survey Manual.” In line with conventional usage in the engineering profession and with traditional usage in published soil surveys, this rate of flow continues to be expressed as “permeability.” Terms describing permeability, measured in inches per hour, are as follows:

Impermeable	less than 0.0,015 inch
Very slow	0.0,015 to 0.06 inch
Slow	0.06 to 0.2 inch
Moderately slow	0.2 to 0.6 inch
Moderate	0.6 inch to 2.0 inches
Moderately rapid	2.0 to 6.0 inches
Rapid	6.0 to 20 inches
Very rapid	more than 20 inches

Phase, soil. A subdivision of a soil series based on features that affect its use and management, such as slope, stoniness, and flooding.

pH value. A numerical designation of acidity and alkalinity in soil. (See Reaction, soil.)

Piping (in tables). Formation of subsurface tunnels or pipelike cavities by water moving through the soil.

Plasticity index. The numerical difference between the liquid limit and the plastic limit; the range of moisture content within which the soil remains plastic.

Plastic limit. The moisture content at which a soil changes from semisolid to plastic.

Plateau. An extensive upland mass with relatively flat summit area that is considerably elevated (more than 100 meters) above adjacent lowlands and separated from them on one or more sides by escarpments.

Playa. The generally dry and nearly level lake plain that occupies the lowest parts of closed depressional areas, such as those on intermontane basin floors. Temporary flooding occurs primarily in response to precipitation and runoff.

Ponding. Standing water on soils in closed depressions. Unless the soils are artificially drained, the water can be removed only by percolation or evapotranspiration.

Poorly graded. Refers to a coarse grained soil or soil material consisting mainly of particles of nearly the same size. Because there is little difference in size of the particles, density can be increased only slightly by compaction.

Potential native plant community. See Climax plant community.

Potential rooting depth (effective rooting depth). Depth to which roots could penetrate if the content of moisture in the soil were adequate. The soil has no properties restricting the penetration of roots to this depth.

Productivity, soil. The capability of a soil for producing a specified plant or sequence of plants under specific management.

Profile, soil. A vertical section of the soil extending through all its horizons and into the parent material.

Rangeland. Land on which the potential natural vegetation is predominantly grasses,

grasslike plants, forbs, or shrubs suitable for grazing or browsing. It includes natural grasslands, savannas, many wetlands, some deserts, tundras, and areas that support certain forb and shrub communities.

Reaction, soil. A measure of acidity or alkalinity of a soil, expressed in pH values. A soil that tests to pH 7.0 is described as precisely neutral in reaction because it is neither acid nor alkaline. The degrees of acidity or alkalinity, expressed as pH values, are:

Ultra acid	less than 3.5
Extremely acid	3.5 to 4.4
Very strongly acid	4.5 to 5.0
Strongly acid	5.1 to 5.5
Moderately acid	5.6 to 6.0
Slightly acid	6.1 to 6.5
Neutral	6.6 to 7.3
Slightly alkaline	7.4 to 7.8
Moderately alkaline	7.9 to 8.4
Strongly alkaline	8.5 to 9.0
Very strongly alkaline	9.1 and higher

Redoximorphic concentrations. Nodules, concretions, soft masses, pore linings, and other features resulting from the accumulation of iron or manganese oxide. An indication of chemical reduction and oxidation resulting from saturation.

Redoximorphic depletions. Low-chroma zones from which iron and manganese oxide or a combination of iron and manganese oxide and clay has been removed. These zones are indications of the chemical reduction of iron resulting from saturation.

Redoximorphic features. Redoximorphic concentrations, redoximorphic depletions, reduced matrices, a positive reaction to alpha,alpha-dipyridyl, and other features indicating the chemical reduction and oxidation of iron and manganese compounds resulting from saturation.

Reduced matrix. A soil matrix that has low chroma in situ because of chemically reduced iron (Fe II). The chemical reduction results from nearly continuous wetness. The matrix undergoes a change in hue or chroma within 30 minutes after exposure to air as the iron is oxidized (Fe III). A type of redoximorphic feature.

Regolith. The unconsolidated mantle of weathered rock and soil material on the earth’s surface; the loose earth material above the solid rock.

Relief. The elevations or inequalities of a land surface, considered collectively.

Residuum (residual soil material). Unconsolidated, weathered or partly weathered mineral material that accumulated as consolidated rock disintegrated in place.

Rill. A steep-sided channel resulting from accelerated erosion. A rill generally is a few inches deep and not wide enough to be an obstacle to farm machinery.

Road cut. A sloping surface produced by mechanical means during road construction. It is commonly on the uphill side of the road.

Rock fragments. Rock or mineral fragments having a diameter of 2 millimeters or more; for example, pebbles, cobbles, stones, and boulders.

Root zone. The part of the soil that can be penetrated by plant roots.

Runoff. The precipitation discharged into stream channels from an area. The water that flows off the surface of the land without sinking into the soil is called surface runoff. Water that enters the soil before reaching surface streams is called ground-water runoff or seepage flow from ground water.

Saline soil. A soil containing soluble salts in an amount that impairs growth of plants. A saline soil does not contain excess exchangeable sodium.

Sand. As a soil separate, individual rock or mineral fragments from 0.05 millimeter to 2.0 millimeters in diameter. Most sand grains consist of quartz. As a soil textural class, a soil that is 85 percent or more sand and not more than 10 percent clay.

Sandstone. Sedimentary rock containing dominantly sand-sized particles.

Saprolite. Unconsolidated residual material underlying the soil and grading to hard bedrock below.

Saturation. Wetness characterized by zero or positive pressure of the soil water. Under conditions of saturation, the water will flow from the soil matrix into an unlined auger hole.

Sedimentary rock. Rock made up of particles deposited from suspension in water. The chief kinds of sedimentary rock are conglomerate, formed from gravel; sandstone, formed from sand; shale, formed from clay; and limestone, formed from soft masses of calcium carbonate. There are many intermediate types. Some wind-deposited sand is consolidated into sandstone.

Sequum. A sequence consisting of an illuvial horizon and the overlying eluvial horizon. (See Eluviation.)

Series, soil. A group of soils that have profiles that are almost alike, except for differences in texture of the surface layer. All the soils of a series have horizons that are similar in composition, thickness, and arrangement.

Shale. Sedimentary rock formed by the hardening of a clay deposit.

Sheet erosion. The removal of a fairly uniform layer of soil material from the land surface by the action of rainfall and surface runoff.

Shoulder. The position that forms the uppermost inclined surface near the top of a hillslope. It is a transition from backslope to summit. The surface is dominantly convex in profile and erosional in origin.

Shrink-swell (in tables). The shrinking of soil when dry and the swelling when wet. Shrinking and swelling can damage roads, dams, building foundations, and other structures. It can also damage plant roots.

Side slope. A geomorphic component of hills consisting of a laterally planar area of a hillside. The overland waterflow is predominantly parallel.

Silica. A combination of silicon and oxygen. The mineral form is called quartz.

Silt. As a soil separate, individual mineral particles that range in diameter from the upper limit of clay (0.002 millimeter) to the lower limit of very fine sand (0.05 millimeter). As a soil textural class, soil that is 80 percent or more silt and less than 12 percent clay.

Siltstone. Sedimentary rock made up of dominantly silt-sized particles.

Similar soils. Soils that share limits of diagnostic criteria, behave and perform in a similar manner, and have similar conservation needs or management requirements for the major land uses in the survey area.

Site index. A designation of the quality of a forest site based on the height of the dominant stand at an arbitrarily chosen age. For example, if the average height attained by dominant and codominant trees in a fully stocked stand at the age of 50 years is 75 feet, the site index is 75.

Slope. The inclination of the land surface from the horizontal. Percentage of slope is the vertical distance divided by horizontal distance, then multiplied by 100. Thus, a slope of 20 percent is a drop of 20 feet in 100 feet of horizontal distance.

Slow refill (in tables). The slow filling of ponds, resulting from restricted permeability in the soil.

Sodic (alkali) soil. A soil having so high a degree of alkalinity (pH 8.5 or higher) or so high a percentage of exchangeable sodium (15 percent or more of the total exchangeable bases), or both, that plant growth is restricted.

Sodicity. The degree to which a soil is affected by exchangeable sodium. Sodicity is

expressed as a sodium adsorption ratio (SAR) of a saturation extract, or the ratio of Na^{+} to Ca^{++} + Mg^{++}. The degrees of sodicity and their respective ratios are:

Slight	less than 13:1
Moderate	13-30:1
Strong	more than 30:1

Sodium adsorption ratio (SAR). A measure of the amount of sodium (Na) relative to calcium (Ca) and magnesium (Mg) in the water extract from saturated soil paste. It is the ratio of the Na concentration divided by the square root of one-half of the Ca + Mg concentration.

Soft bedrock. Bedrock that can be excavated with trenching machines, backhoes, small rippers, and other equipment commonly used in construction.

Soil. A natural, three-dimensional body at the earth's surface. It is capable of supporting plants and has properties resulting from the integrated effect of climate and living matter acting on earthy parent material, as conditioned by relief over periods of time.

Soil separates. Mineral particles less than 2 millimeters in equivalent diameter and ranging between specified size limits. The names and sizes, in millimeters, of separates recognized in the United States are as follows:

Very coarse sand	2.0 to 1.0
Coarse sand	1.0 to 0.5
Medium sand	0.5 to 0.25
Fine sand	0.25 to 0.10
Very fine sand	0.10 to 0.05
Silt	0.05 to 0.002
Clay	less than 0.002

Solum. The upper part of a soil profile, above the C horizon, in which the processes of soil formation are active. The solum in soil consists of the A, E, and B horizons. Generally, the characteristics of the material in these horizons are unlike those of the material below the solum. The living roots and plant and animal activities are largely confined to the solum.

Stones. Rock fragments 10 to 24 inches (25 to 60 centimeters) in diameter if rounded or 15 to 24 inches (38 to 60 centimeters) in length if flat.

Stony. Refers to a soil containing stones in numbers that interfere with or prevent tillage.

Structure, soil. The arrangement of primary soil particles into compound particles or aggregates. The principal forms of soil structure are—platy (laminated), prismatic (vertical axis of aggregates longer than horizontal), columnar (prisms with rounded tops), blocky (angular or subangular), and granular. Structureless soils are either single grained(each grain by itself, as in dune sand) or massive (the particles adhering without any regular cleavage, as in many hardpans).

Subsoil. Technically, the B horizon; roughly, the part of the solum below plow depth.

Substratum. The part of the soil below the solum.

Subsurface layer. Any surface soil horizon (A, E, AB, or EB) below the surface layer.

Summit. The topographically highest position of a hillslope. It has a nearly level (planar or only slightly convex) surface.

Surface layer. The soil ordinarily moved in tillage, or its equivalent in uncultivated soil, ranging in depth from 4 to 10 inches (10 to 25 centimeters). Frequently designated as the "plow layer," or the "Ap horizon."

Surface soil. The A, E, AB, and EB horizons, considered collectively. It includes all subdivisions of these horizons.

Talus. Fragments of rock and other soil material accumulated by gravity at the foot of cliffs or steep slopes.

Taxadjuncts. Soils that cannot be classified in a series recognized in the classification system. Such soils are named for a series they strongly resemble and are designated as taxadjuncts to that series because they differ in ways too small to be of consequence in interpreting their use and behavior. Soils are recognized as taxadjuncts only when one or more of their characteristics are slightly outside the range defined for the family of the series for which the soils are named.

Terrace (geologic). An old alluvial plain, ordinarily flat or undulating, bordering a river, a lake, or the sea.

Texture, soil. The relative proportions of sand, silt, and clay particles in a mass of soil. The basic textural classes, in order of increasing proportion of fine particles, are sand, loamy sand, sandy loam, loam, silt loam, silt, sandy clay loam, clay loam, silty clay loam, sandy clay, silty clay, and clay. The sand, loamy sand, and sandy loam classes may be further divided by specifying “coarse,” “fine,” or “very fine.”

Thin layer (in tables). Otherwise suitable soil material that is too thin for the specified use.

Toeslope. The position that forms the gently inclined surface at the base of a hillslope. Toeslopes in profile are commonly gentle and linear and are constructional surfaces forming the lower part of a hillslope continuum that grades to valley or closed-depression floors.

Topsoil. The upper part of the soil, which is the most favorable material for plant growth. It is ordinarily rich in organic matter and is used to topdress roadbanks, lawns, and land affected by mining.

Weathering. All physical and chemical changes produced in rocks or other deposits at or near the earth’s surface by atmospheric agents. These changes result in disintegration and decomposition of the material.

Well graded. Refers to soil material consisting of coarse grained particles that are well distributed over a wide range in size or diameter. Such soil normally can be easily increased in density and bearing properties by compaction. Contrasts with poorly graded soil.

Wilting point (or permanent wilting point). The moisture content of soil, on an ovendry basis, at which a plant (specifically a sunflower) wilts so much that it does not recover when placed in a humid, dark chamber.

Tables

Table 1.--Temperature and Precipitation

(Recorded in the period 1971-2000 at Natural Bridges National Monument, UT6053)

Month	Temperature						Precipitation				
				2 years in 10 will have--				2 years in 10 will have--			
	Average daily maximum	Average daily minimum	Average	Maximum temperature higher than--	Minimum temperature lower than--	Average number of growing degree days*	Average	Less than--	More than--	Average number of days with 0.10 inch or more	Average snowfall
	°F	°F	°F	°F	°F	Units	In	In	In		In
January----	39.7	18.5	29.1	56	-3	5	1.04	0.28	1.81	3	11.9
February---	44.8	23.2	34.0	61	2	22	0.75	0.29	1.13	2	5.6
March------	52.1	28.8	40.4	70	11	100	1.15	0.30	1.97	3	5.5
April------	61.3	34.4	47.8	79	17	260	0.83	0.16	1.58	2	2.7
May--------	71.8	43.0	57.4	87	27	540	0.81	0.22	1.40	2	0.2
June-------	83.8	52.5	68.2	96	35	845	0.46	0.02	0.76	1	0.0
July-------	89.0	58.9	73.9	99	48	1052	1.16	0.38	1.91	3	0.0
August-----	86.2	57.3	71.8	97	47	983	1.48	0.38	2.43	3	0.0
September--	77.5	49.8	63.7	91	32	707	1.24	0.40	1.97	3	0.0
October----	64.5	38.8	51.6	82	19	374	1.52	0.41	2.53	3	1.0
November---	49.3	27.5	38.4	68	7	80	0.97	0.29	1.64	2	4.8
December---	40.8	19.8	30.3	56	0	7	0.83	0.18	1.31	2	7.5
Yearly:											
Average---	63.4	37.7	50.5	---	---	---	---	---	---	---	---
Extreme---	103	-14	---	99	-6	---	---	---	---	---	---
Total-----	---	---	---	---	---	4974	12.24	9.65	14.76	29	39.2

Average number of days per year with at least 1 inch of snow on the ground: 47

* A growing degree day is a unit of heat available for plant growth. It can be calculated by adding the maximum and minimum daily temperatures, dividing the sum by 2, and subtracting the temperature below which growth is minimal for the principal crops in the area (Threshold: 40 degrees F).

Table 2.--Freeze Dates in Spring and Fall

(Recorded in the period 1965-1990 at Natural Bridges National Monument, UT6053

Probability	Temperature		
	24 oF or lower	28 oF or lower	32 oF or lower
Last freezing temperature in spring:			
1 year in 10 later than--	May 6	May 20	May 30
2 years in 10 later than--	April 28	May 13	May 24
5 years in 10 later than--	April 14	May 1	May 14
First freezing temperature in fall:			
1 year in 10 earlier than--	Oct. 8	Sept. 29	Sept. 17
2 years in 10 earlier than--	Oct. 15	Oct. 6	Sept. 24
5 years in 10 earlier than--	Oct. 30	Oct. 21	Oct. 8

Table 3.--Growing Season

(Recorded in the period 1971-2000 at Natural Bridges National Monument, UT6053)

Probability	Daily minimum temperature during growing season		
	Higher than 24 ^{o}F	Higher than 28 ^{o}F	Higher than 32 ^{o}F
	Days	Days	Days
Probability			
9 years in 10	174	154	121
8 years in 10	184	162	130
5 years in 10	203	176	147
2 years in 10	223	190	164
1 year in 10	233	197	172

Table 4.--Taxonomic Classification of the Soils

(An asterisk in the first column indicates a taxadjunct to the series. See text for a description of those characteristics that are outside the range of the series.)

Soil name	Family or higher taxonomic class
Bamac	Sandy-skeletal, mixed, mesic Aridic Ustorthents
Gladel	Loamy, mixed, superactive, mesic Aridic Lithic Haplustepts
Levante family	Sandy, mixed, mesic Aridic Ustifluvents
Metuck	Loamy-skeletal, mixed, superactive, calcareous, mesic Aridic Lithic Ustorthents
*Nizhoni	Loamy, mixed, superactive, calcareous, mesic Aridic Lithic Ustorthents
Nomrah	Fine-loamy, mixed, superactive, mesic Calcidic Haplustalfs
*Plumasano	Coarse-loamy, mixed, superactive, mesic Aridic Calciustepts
Tanoan family	Coarse-loamy, mixed, superactive, mesic Aridic Calciustepts

Table 5.--Acreage and Proportionate Extent of the Soils

Map symbol	Soil name	Acres	Percent
69	Nomrah-Plumasano-Gladel complex, 2 to 8 percent slopes	492	6.4
70	Plumasano-Tanoan family-Gladel complex, 2 to 50 percent slopes	963	12.6
71	Gladel-Rock outcrop complex, 5 to 15 percent slopes	3,087	40.5
72	Rock outcrop-Nizhoni-Bamac complex, 5 to 60 percent slopes	2,719	35.6
73	Levante family complex, 0 to 15 percent slopes	350	4.6
74	Metuck very gravelly sandy loam, 25 to 65 percent slopes	25	0.3
	Total	7,636	100.0

Table 6.--Ecological Sites and Characteristic Plant Communities

(Composition of forest understory based on understory productivity; range sites based on percent dry weight. Forest understory is production under 12 feet in height. Characteristic plant are pulled from the component existing plants tables in the National Soils Information System (NASIS) Absence of an entry indicates the species totalled less than one percent of annual production.)

Map unit symbol and soil name	Ecological site name and number	Total production: Kind of year	Total production: Dry weight	Characteristic plants	Composition: Forest	Composition: Range
			Lb/ac		Pct	Pct
69:						
Nomrah----------	Upland Loam (Big Sagebrush) (R036XY306UT)	Favorable	700	basin big sagebrush		30
		Normal	500	Utah juniper		20
		Unfavorable	300	Wright birdbeak		10
				pinyon		10
				lobeleaf groundsel		5
Plumasano-------	Upland Loam (Pinyon/Utah Juniper) (R036XY307UT)	Favorable	650	Utah juniper		45
		Normal	450	basin big sagebrush		13
		Unfavorable	300	Wright birdbeak		5
				pinyon		5
				lobeleaf groundsel		4
Gladel----------	Upland Shallow Loam (Pinyon/Utah Juniper) (R036XY315UT)	Favorable	600	Utah juniper		30
		Normal	450	pinyon		25
		Unfavorable	300	basin big sagebrush		15
				Mormon tea		3
				lobeleaf groundsel		3
70:						
Plumasano-------	Upland Loam (Pinyon/Utah Juniper) (R036XY307UT)	Favorable	650	Utah juniper		45
		Normal	450	basin big sagebrush		13
		Unfavorable	300	Wright birdbeak		5
				pinyon		5
				lobeleaf groundsel		4
Tanoan Family---	Upland Dissected Slope (Pinyon/Utah Juniper) (R036XY302UT)	Favorable	300	Utah juniper		30
		Normal	250	pinyon		30
		Unfavorable	200	roundleaf buffaloberry		20
				Mormon tea		2
				Wright birdbeak		1
70:						
Gladel----------	Upland Shallow Loam (Pinyon/Utah Juniper) (R036XY315UT)	Favorable	600	Utah juniper		30
		Normal	450	pinyon		25
		Unfavorable	300	basin big sagebrush		15
				Mormon tea		3
				lobeleaf groundsel		3
71:						
Gladel----------	Upland Shallow Loam (Pinyon/Utah Juniper) (R036XY315UT)	Favorable	700	Utah juniper		30
		Normal	500	pinyon		25
		Unfavorable	400	broom snakeweed		10
				Mormon tea		5
				lobeleaf groundsel		3

Table 6.-- Ecological Sites and Characteristic Plant Communities--Continued

Map unit symbol and soil name	Ecological site name and number	Total production: Kind of year	Total production: Dry weight	Characteristic plants	Composition: Forest	Composition: Range
			Lb/ac		Pct	Pct
72:						
Nizhoni----------	Upland Shallow Loam (Littleleaf Mountain Mahogany) (R036XY316UT)	Favorable	550	Utah juniper		20
		Normal	450	pinyon		20
		Unfavorable	350	Indian ricegrass		10
				littleleaf mountain-mahogany		8
				Utah serviceberry		5
Bamac-----------	Upland Very Steep Stony Loam (Pinyon/Utah Juniper) (R036XY328UT)	Favorable	700	Salina wildrye		30
		Normal	600	pinyon		15
		Unfavorable	500	Utah juniper		10
				Utah serviceberry		7
				roundleaf buffaloberry		5
73:						
Levante Family--	Loamy Terrace (Basin Big Sagebrush/Oakbrush) (R036XY011UT)	Favorable	1700	basin big sagebrush		20
		Normal	1300	Gambel oak		10
		Unfavorable	900	Indian ricegrass		10
				Utah juniper		5
				Utah serviceberry		5
				muttongrass		5
				needle and thread		5
Levante Family, frequently flooded--------	Semi-wet Fresh Streambank (Freemont Cottonwood) (R036XY013UT)	Favorable	1500	Fremont cottonwood		15
		Normal	1300	willow		15
		Unfavorable	1000	Canada wildrye		10
				basin big sagebrush		10
				Baltic rush		5
				fragrant sumac		5
				skyrocket gilia		3
74:						
Metuck----------	Upland Very Steep Stony Loam (Pinyon/Utah Juniper) (R036XY328UT)	Favorable	700	Salina wildrye		15
		Normal	600	Utah juniper		15
		Unfavorable	500	Bigelow sagebrush		10
				Utah serviceberry		10
				mountain mahogany		10
				roundleaf buffaloberry		10
				Indian ricegrass		8
				pinyon		8
				fineleaf hymenopappus		3
				galleta		3

Table 7.--Index of Plant Symbols, Common Names and Scientific Names

Plants displayed occur within the National Soils Information System (NASIS) plant tables used for the soil survey area. The scientific and common names are referenced at the USDA PLANTS database: plants.usda.gov

Plant Symbol	Local Common Name	Scientific Name
ACHY	Indian ricegrass	Achnatherum hymenoides
AMUT	Utah serviceberry	Amelanchier utahensis
ARBI3	Bigelow sagebrush	Artemisia bigelovii
ARTRT	basin big sagebrush	Artemisia tridentata ssp. tridentata
BOGR2	blue grama	Bouteloua gracilis
CEIN7	littleleaf mountain-mahogany	Cercocarpus intricatus
CERCO	mountain mahogany	Cercocarpus
COWR2	Wright birdbeak	Cordylanthus wrightii
ELCA4	Canada wildrye	Elymus canadensis
EPVI	Mormon tea	Ephedra viridis
GUSA2	broom snakeweed	Gutierrezia sarothrae
HECOC8	needle and thread	Hesperostipa comata ssp. comata
HYFI	fineleaf hymenopappus	Hymenopappus filifolius
IPAG	skyrocket gilia	Ipomopsis aggregata
JUBA	Baltic rush	Juncus balticus
JUOS	Utah juniper	Juniperus osteosperma
KRLA2	winterfat	Krascheninnikovia lanata
LESA4	Salina wildrye	Leymus salinus
PAMU11	lobeleaf groundsel	Packera multilobata
PIED	pinyon	Pinus edulis
PIED	twoneedle pinyon	Pinus edulis
PLJA	galleta	Pleuraphis jamesii
POFE	muttongrass	Poa fendleriana
POFR2	Fremont cottonwood	Populus fremontii
QUGA	Gambel oak	Quercus gambelii
RHAR4	fragrant sumac	Rhus aromatica
SALIX	willow	Salix
SHRO	roundleaf buffaloberry	Shepherdia rotundifolia

Table 8.--Index of Common Names, Plant Symbols and Scientific Names

Plants displayed occur within the National Soils Information System (NASIS) plant tables used for the soil survey area. The scientific and common names are referenced at the USDA PLANTS database: plants.usda.gov

Local Common Name	Plant Symbol	Scientific Name
Baltic rush	JUBA	Juncus balticus
basin big sagebrush	ARTRT	Artemisia tridentata ssp. tridentata
Bigelow sagebrush	ARBI3	Artemisia bigelovii
blue grama	BOGR2	Bouteloua gracilis
broom snakeweed	GUSA2	Gutierrezia sarothrae
Canada wildrye	ELCA4	Elymus canadensis
fineleaf hymenopappus	HYFI	Hymenopappus filifolius
fragrant sumac	RHAR4	Rhus aromatica
Fremont cottonwood	POFR2	Populus fremontii
galleta	PLJA	Pleuraphis jamesii
Gambel oak	QUGA	Quercus gambelii
Indian ricegrass	ACHY	Achnatherum hymenoides
littleleaf mountain-mahogany	CEIN7	Cercocarpus intricatus
lobeleaf groundsel	PAMU11	Packera multilobata
Mormon tea	EPVI	Ephedra viridis
mountain mahogany	CERCO	Cercocarpus
muttongrass	POFE	Poa fendleriana
needle and thread	HECOC8	Hesperostipa comata ssp. comata
pinyon	PIED	Pinus edulis
roundleaf buffaloberry	SHRO	Shepherdia rotundifolia
Salina wildrye	LESA4	Leymus salinus
skyrocket gilia	IPAG	Ipomopsis aggregata
twoneedle pinyon	PIED	Pinus edulis
Utah juniper	JUOS	Juniperus osteosperma
Utah serviceberry	AMUT	Amelanchier utahensis
willow	SALIX	Salix
winterfat	KRLA2	Krascheninnikovia lanata
Wright birdbeak	COWR2	Cordylanthus wrightii

Table 9.--Forest Productivity

Map unit symbol and soil name	Potential productivity				Volume of wood fiber (CMAI)
	Characteristic trees	Site index base	Site index base age	Site index in feet	
			yrs	low-rv-high	cu ft/ac/yr low-rv-high
69:					
Plumasano	twoneedle pinyon	---		-44-	-14-
	Utah juniper	---		-44-	-14-
70:					
Plumasano	twoneedle pinyon	---		-44-	-14-
	Utah juniper	---		-44-	-14-

Table 10.--Land Management - Suitability for Planting and Soil Rutting Hazard

(The information in this table indicates the dominant soil condition but does not eliminate the need for onsite investigation. The numbers in the value columns range from 0.01 to 1.00. The larger the value, the greater the limitation. See text for further explanation of ratings in this table.)

Map symbol and soil name	Pct. of map unit	Suitability for hand planting		Suitability for mechanical planting		Soil Rutting Hazard	
		Rating class and limiting features	Value	Rating class and limiting features	Value	Rating class and limiting features	Value
69:							
Nomrah	55	Well suited		Well suited		Severe	
						Low strength	1.00
Plumasano	25	Well suited		Well suited		Moderate	
						Low strength	0.50
Gladel	15	Well suited		Moderately suited		Moderate	
				Slope	0.50	Low strength	0.50
70:							
Plumasano	50	Well suited		Moderately suited		Severe	
				Slope	0.50	Low strength	1.00
Tanoan family	20	Moderately suited		Unsuited		Severe	
		Slope	0.50	Slope	1.00	Low strength	1.00
				Rock fragments	0.50		
Gladel	15	Well suited		Moderately suited		Moderate	
				Slope	0.50	Low strength	0.50
				Rock fragments	0.50		
71:							
Gladel	70	Unsuited		Unsuited		Moderate	
		Restrictive layer	1.00	Restrictive layer	1.00	Low strength	0.50
				Slope	0.50		
72:							
Nizhoni	15	Unsuited		Unsuited		Moderate	
		Restrictive layer	1.00	Restrictive layer	1.00	Low strength	0.50
				Slope	0.50		
Bamac	15	Poorly suited		Unsuited		Moderate	
		Rock fragments	0.75	Rock fragments	1.00	Low strength	0.50
		Sandiness	0.50	Slope	1.00		
		Slope	0.50	Sandiness	0.50		
73:							
Levante family	65	Well suited		Moderately suited		Moderate	
				Slope	0.50	Low strength	0.50
Levante family, frequently flooded	20	Well suited		Moderately suited		Moderate	
				Slope	0.50	Low strength	0.50
74:							
Metuck	90	Unsuited		Unsuited		Moderate	
		Restrictive layer	1.00	Slope	1.00	Low strength	0.50
		Rock fragments	0.75	Rock fragments	1.00		
		Slope	0.50	Restrictive layer	1.00		

Table 11.--Land Management - Hazard of Erosion and Suitability for Roads

(The information in this table indicates the dominant soil condition but does not eliminate the need for onsite investigation. The numbers in the value columns range from 0.01 to 1.00. The larger the value, the greater the limitation. See text for further explanation of ratings in this table.)

Map symbol and soil name	Pct. of map unit	Hazard of off-road or off-trail erosion		Hazard of erosion on roads and trails		Suitability for roads (natural surface)	
		Rating class and limiting features	Value	Rating class and limiting features	Value	Rating class and limiting features	Value
69:							
Nomrah	55	Slight		Moderate		Moderately suited	
				Slope/erodibility	0.50	Low strength	0.50
Plumasano	25	Slight		Slight		Well suited	
Gladel	15	Slight		Moderate		Moderately suited	
				Slope/erodibility	0.50	Slope	0.50
70:							
Plumasano	50	Moderate		Severe		Moderately suited	
		Slope/erodibility	0.50	Slope/erodibility	0.95	Slope	0.50
						Low strength	0.50
Tanoan family	20	Severe		Severe		Poorly suited	
		Slope/erodibility	0.75	Slope/erodibility	0.95	Slope	1.00
Gladel	15	Slight		Moderate		Well suited	
				Slope/erodibility	0.50		
71:							
Gladel	70	Slight		Moderate		Moderately suited	
				Slope/erodibility	0.50	Slope	0.50
72:							
Nizhoni	15	Moderate		Severe		Moderately suited	
		Slope/erodibility	0.50	Slope/erodibility	0.95	Slope	0.50
						Low strength	0.50
Bamac	15	Severe		Severe		Poorly suited	
		Slope/erodibility	0.75	Slope/erodibility	0.95	Rock fragments	1.00
						Slope	1.00
73:							
Levante family	65	Slight		Moderate		Moderately suited	
				Slope/erodibility	0.50	Flooding	0.50
Levante family, frequently flooded	20	Slight		Moderate		Poorly suited	
				Slope/erodibility	0.50	Flooding	1.00
74:							
Metuck	90	Very severe		Severe		Poorly suited	
		Slope/erodibility	0.95	Slope/erodibility	0.95	Rock fragments	1.00
						Slope	1.00

Table 12.--Land Management - Site Preparation

(The information in this table indicates the dominant soil condition but does not eliminate the need for onsite investigation. The numbers in the value columns range from 0.01 to 1.00. The larger the value, the greater the limitation. See text for further explanation of ratings in this table.)

Map symbol and soil name	Pct. of map unit	Suitability for mechanical site preparation (surface): Rating class and limiting features	Value	Suitability for mechanical site preparation (deep): Rating class and limiting features	Value
69:					
Nomrah	55	Well suited		Well suited	
Plumasano	25	Well suited		Well suited	
Gladel	15	Well suited		Unsuited	
				Restrictive layer	1.00
70:					
Plumasano	50	Well suited		Well suited	
Tanoan family	20	Unsuited		Unsuited	
		Slope	1.00	Slope	1.00
				Restrictive layer	0.50
Gladel	15	Well suited		Unsuited	
				Restrictive layer	1.00
71:					
Gladel	70	Unsuited		Unsuited	
		Restrictive layer	1.00	Restrictive layer	1.00
72:					
Nizhoni	15	Unsuited		Unsuited	
		Restrictive layer	1.00	Restrictive layer	1.00
Bamac	15	Unsuited		Unsuited	
		Rock fragments	1.00	Slope	1.00
		Slope	1.00	Rock fragments	1.00
73:					
Levante family	65	Well suited		Well suited	
Levante family, frequently flooded	20	Well suited		Well suited	
74:					
Metuck	90	Unsuited		Unsuited	
		Rock fragments	1.00	Slope	1.00
		Slope	1.00	Rock fragments	1.00
		Restrictive layer	1.00	Restrictive layer	1.00

Table 13.--Land Management - Damage by Fire and Seedling Mortality

(The information in this table indicates the dominant soil condition but does not eliminate the need for onsite investigation. The numbers in the value columns range from 0.01 to 1.00. The larger the value, the greater the limitation. See text for further explanation of ratings in this table.)

Map symbol and soil name	Pct. of map unit	Potential for damage to soil by fire		Potential for seedling mortality	
		Rating class and limiting features	Value	Rating class and limiting features	Value
69:					
Nomrah	55	Moderate		Moderate	
		Texture/surface depth/rock fragments	0.50	Available water	0.50
				Soil reaction	0.50
Plumasano	25	Moderate		High	
		Texture/surface depth/rock fragments	0.50	Available water	1.00
				Soil reaction	0.50
Gladel	15	Moderate		High	
		Texture/surface depth/rock fragments	0.50	Available water	1.00
				Soil reaction	0.50
70:					
Plumasano	50	High		Moderate	
		Texture/surface depth/rock fragments	1.00	Soil reaction	0.50
				Available water	0.50
Tanoan family	20	High		High	
		Texture/slope/ surface depth/ rock fragments	1.00	Available water	1.00
				Soil reaction	0.50
				Carbonate content	0.50
Gladel	15	Moderate		High	
		Texture/surface depth/rock fragments	0.50	Available water	1.00
71:					
Gladel	70	Moderate		High	
		Texture/surface depth/rock fragments	0.50	Available water	1.00
				Soil reaction	0.50

Table 13.--Land Management-Damage by Fire and Seedling Mortality--Continued

Map symbol and soil name	Pct. of map unit	Potential for damage to soil by fire: Rating class and limiting features	Value	Potential for seedling mortality: Rating class and limiting features	Value
72:					
Nizhoni	15	High		High	
		Texture/surface depth/rock fragments	1.00	Available water	1.00
				Soil reaction	0.50
Bamac	15	High		High	
		Texture/slope/ rock fragments	1.00	Available water	1.00
				Soil reaction	0.50
73:					
Levante family	65	Moderate		High	
		Texture/rock fragments	0.50	Available water	1.00
				Soil reaction	0.50
Levante family, frequently flooded	20	High		High	
		Texture/surface depth/rock fragments	1.00	Available water	1.00
				Soil reaction	0.50
74:					
Metuck	90	Moderate		Moderate	
		Texture/slope/ surface depth/ rock fragments	0.50	Soil reaction	0.50

Table 14.--Camp and Picnic Areas

(The information in this table indicates the dominant soil condition but does not eliminate the need for onsite investigation. The numbers in the value columns range from 0.01 to 1.00. The larger the value, the greater the limitation. See text for further explanation of ratings in this table.)

Map symbol and soil name	Pct. of map unit	Camp areas		Picnic areas	
		Rating class and limiting features	Value	Rating class and limiting features	Value
69:					
Nomrah	55	Somewhat limited		Somewhat limited	
		Dusty	0.50	Dusty	0.50
		Too sandy	0.12	Too sandy	0.12
Plumasano	25	Not limited		Not limited	
Gladel	15	Very limited		Very limited	
		Depth to bedrock	1.00	Depth to bedrock	1.00
70:					
Plumasano	50	Somewhat limited		Somewhat limited	
		Too sandy	0.88	Too sandy	0.88
		Slope	0.16	Slope	0.16
Tanoan family	20	Very limited		Very limited	
		Too steep	1.00	Too steep	1.00
		Dusty	0.50	Dusty	0.50
Gladel	15	Very limited		Very limited	
		Depth to bedrock	1.00	Depth to bedrock	1.00
		Too sandy	0.32	Too sandy	0.32
71:					
Gladel	70	Not rated		Not rated	
		Not rated; Surface Fragments > 75mm		Not rated; Surface Fragments > 75mm	
		Depth to bedrock	1.00	Depth to bedrock	1.00
		Slope	0.16	Slope	0.16
72:					
Nizhoni	15	Very limited		Very limited	
		Depth to bedrock	1.00	Depth to bedrock	1.00
		Too sandy	0.31	Too sandy	0.31
		Slope	0.16	Slope	0.16
Bamac	15	Very limited		Very limited	
		Too steep	1.00	Large stones content	1.00
		Large stones content	1.00	Too steep	1.00
		Too sandy	0.81	Too sandy	0.81
		Gravel content	0.01	Gravel content	0.01

Table 14.--Camp and Picnic Areas--Continued

Map symbol and soil name	Pct. of map unit	Camp areas: Rating class and limiting features	Camp areas: Value	Picnic areas: Rating class and limiting features	Picnic areas: Value
73:					
Levante family------	65	Very limited		Somewhat limited	
		Flooding	1.00	Too sandy	0.98
		Too sandy	0.98		
Levante family, frequently flooded-	20	Very limited		Somewhat limited	
		Flooding	1.00	Too sandy	0.98
		Too sandy	0.98	Flooding	0.40
74:					
Metuck--------------	90	Very limited		Very limited	
		Too steep	1.00	Large stones content	1.00
		Large stones content	1.00	Too steep	1.00
		Depth to bedrock	1.00	Depth to bedrock	1.00
		Gravel content	0.99	Gravel content	0.99

Table 15.--Trail Management

(The information in this table indicates the dominant soil condition but does not eliminate the need for onsite investigation. The numbers in the value columns range from 0.01 to 1.00. The larger the value, the greater the limitation. See text for further explanation of ratings in this table.)

Map symbol and soil name	Pct. of map unit	Foot traffic and equestrian trails: Rating class and limiting features	Value	Mountain bike and off-road vehicle trails: Rating class and limiting features	Value
69:					
Nomrah	55	Somewhat limited		Somewhat limited	
		Dusty	0.50	Dusty	0.50
		Too sandy	0.12	Too sandy	0.12
Plumasano	25	Not limited		Not limited	
Gladel	15	Not limited		Not limited	
70:					
Plumasano	50	Somewhat limited		Somewhat limited	
		Too sandy	0.88	Too sandy	0.88
Tanoan family	20	Very limited		Very limited	
		Slope	1.00	Slope	1.00
		Dusty	0.50	Dusty	0.50
Gladel	15	Somewhat limited		Somewhat limited	
		Too sandy	0.32	Too sandy	0.32
71:					
Gladel	70	Not rated		Not rated	
		Not rated; Surface Fragments > 75mm		Not rated; Surface Fragments > 75mm	
72:					
Nizhoni	15	Somewhat limited		Somewhat limited	
		Too sandy	0.31	Too sandy	0.31
Bamac	15	Very limited		Very limited	
		Large stones content	1.00	Large stones content	1.00
		Slope	1.00	Slope	1.00
		Too sandy	0.81	Too sandy	0.81
73:					
Levante family	65	Somewhat limited		Somewhat limited	
		Too sandy	0.98	Too sandy	0.98
Levante family, frequently flooded	20	Somewhat limited		Somewhat limited	
		Too sandy	0.98	Too sandy	0.98
		Flooding	0.40	Flooding	0.40
74:					
Metuck	90	Very limited		Very limited	
		Large stones content	1.00	Large stones content	1.00
		Slope	1.00	Slope	1.00

Table 16.--Dwellings and Small Commercial Buildings

(The information in this table indicates the dominant soil condition but does not eliminate the need for onsite investigation. The numbers in the value columns range from 0.01 to 1.00. The larger the value, the greater the limitation. See text for further explanation of ratings in this table.)

Map symbol and soil name	Pct. of map unit	Dwellings without basements		Dwellings with basements		Small commercial buildings	
		Rating class and limiting features	Value	Rating class and limiting features	Value	Rating class and limiting features	Value
69:							
Nomrah	55	Not limited		Not limited		Not limited	
Plumasano	25	Not limited		Not limited		Not limited	
Gladel	15	Very limited		Very limited		Very limited	
		Depth to hard bedrock	1.00	Depth to hard bedrock	1.00	Depth to hard bedrock	1.00
						Slope	0.50
70:							
Plumasano	50	Somewhat limited		Somewhat limited		Very limited	
		Slope	0.16	Slope	0.16	Slope	1.00
Tanoan family	20	Very limited		Very limited		Very limited	
		Too steep	1.00	Too steep	1.00	Slope	1.00
		Depth to hard bedrock	0.11	Depth to hard bedrock	1.00	Depth to hard bedrock	0.11
Gladel	15	Very limited		Very limited		Very limited	
		Depth to hard bedrock	1.00	Depth to hard bedrock	1.00	Depth to hard bedrock	1.00
						Slope	0.12
71:							
Gladel	70	Very limited		Very limited		Very limited	
		Depth to hard bedrock	1.00	Depth to hard bedrock	1.00	Depth to hard bedrock	1.00
		Slope	0.16	Slope	0.16	Slope	1.00
72:							
Nizhoni	15	Very limited		Very limited		Very limited	
		Depth to hard bedrock	1.00	Depth to hard bedrock	1.00	Depth to hard bedrock	1.00
		Slope	0.16	Slope	0.16	Slope	1.00
Bamac	15	Very limited		Very limited		Very limited	
		Too steep	1.00	Too steep	1.00	Slope	1.00
		Large stones content	0.01	Large stones content	0.01	Large stones content	0.01

Table 16.--Dwellings and Small Commercial Buildings--Continued

Map symbol and soil name	Pct. of map unit	Dwellings without basements		Dwellings with basements		Small commercial buildings	
		Rating class and limiting features	Value	Rating class and limiting features	Value	Rating class and limiting features	Value
73:							
Levante family------	65	Very limited		Very limited		Very limited	
		Flooding	1.00	Flooding	1.00	Flooding	1.00
						Slope	0.12
Levante family, frequently flooded-	20	Very limited		Very limited		Very limited	
		Flooding	1.00	Flooding	1.00	Flooding	1.00
						Slope	0.12
74:							
Metuck--------------	90	Very limited		Very limited		Very limited	
		Too steep	1.00	Too steep	1.00	Slope	1.00
		Depth to hard bedrock	1.00	Depth to hard bedrock	1.00	Depth to hard bedrock	1.00
		Depth to soft bedrock	0.50	Depth to soft bedrock	1.00	Depth to soft bedrock	1.00

Table 17.--Roads and Streets, and Shallow Excavations

(The information in this table indicates the dominant soil condition but does not eliminate the need for onsite investigation. The numbers in the value columns range from 0.01 to 1.00. The larger the value, the greater the limitation. See text for further explanation of ratings in this table.)

Map symbol and soil name	Pct. of map unit	Local roads and streets		Shallow excavations	
		Rating class and limiting features	Value	Rating class and limiting features	Value
69:					
Nomrah	55	Somewhat limited		Somewhat limited	
		Frost action	0.50	Cutbanks cave	0.10
Plumasano	25	Somewhat limited		Somewhat limited	
		Frost action	0.50	Cutbanks cave	0.10
Gladel	15	Very limited		Very limited	
		Depth to hard bedrock	1.00	Depth to hard bedrock	1.00
		Frost action	0.50	Cutbanks cave	0.10
70:					
Plumasano	50	Somewhat limited		Very limited	
		Frost action	0.50	Cutbanks cave	1.00
		Slope	0.16	Slope	0.16
Tanoan family	20	Very limited		Very limited	
		Too steep	1.00	Depth to hard bedrock	1.00
		Frost action	0.50	Too steep	1.00
		Depth to hard bedrock	0.11	Cutbanks cave	0.10
Gladel	15	Very limited		Very limited	
		Depth to hard bedrock	1.00	Depth to hard bedrock	1.00
		Frost action	0.50	Cutbanks cave	0.10
71:					
Gladel	70	Very limited		Very limited	
		Depth to hard bedrock	1.00	Depth to hard bedrock	1.00
		Frost action	0.50	Slope	0.16
		Slope	0.16		

Table 17.--Roads and Streets, and Shallow Excavations--Continued

Map symbol and soil name	Pct. of map unit	Local roads and streets: Rating class and limiting features	Value	Shallow excavations: Rating class and limiting features	Value
72:					
Nizhoni-------------	15	Very limited		Very limited	
		Depth to hard bedrock	1.00	Depth to hard bedrock	1.00
		Frost action	0.50	Slope	0.16
		Slope	0.16		
Bamac---------------	15	Very limited		Very limited	
		Too steep	1.00	Too steep	1.00
		Large stones content	0.01	Cutbanks cave	1.00
				Large stones content	0.01
73:					
Levante family------	65	Very limited		Very limited	
		Flooding	1.00	Cutbanks cave	1.00
				Flooding	0.60
Levante family, frequently flooded-	20	Very limited		Very limited	
		Flooding	1.00	Cutbanks cave	1.00
				Flooding	0.80
74:					
Metuck--------------	90	Very limited		Very limited	
		Depth to hard bedrock	1.00	Depth to hard bedrock	1.00
		Too steep	1.00	Depth to soft bedrock	1.00
		Depth to soft bedrock	1.00	Too steep	1.00
		Frost action	0.50		

Table 18.--Sewage Disposal

(The information in this table indicates the dominant soil condition but does not eliminate the need for onsite investigation. The numbers in the value columns range from 0.01 to 1.00. The larger the value, the greater the limitation. See text for further explanation of ratings in this table.)

Map symbol and soil name	Pct. of map unit	Septic tank absorption fields		Sewage lagoons	
		Rating class and limiting features	Value	Rating class and limiting features	Value
69:					
Nomrah	55	Very limited		Very limited	
		Seepage, bottom layer	1.00	Seepage	1.00
				Slope	0.32
Plumasano	25	Not limited		Very limited	
				Seepage	1.00
				Slope	0.32
Gladel	15	Very limited		Very limited	
		Depth to bedrock	1.00	Depth to hard bedrock	1.00
				Seepage	1.00
				Slope	0.92
70:					
Plumasano	50	Somewhat limited		Very limited	
		Slope	0.16	Seepage	1.00
		Depth to bedrock	0.07	Slope	1.00
Tanoan family	20	Very limited		Very limited	
		Too steep	1.00	Depth to hard bedrock	1.00
		Depth to bedrock	1.00	Slope	1.00
				Seepage	1.00
Gladel	15	Very limited		Very limited	
		Depth to bedrock	1.00	Depth to hard bedrock	1.00
				Seepage	1.00
				Slope	0.68
71:					
Gladel	70	Very limited		Very limited	
		Depth to bedrock	1.00	Depth to hard bedrock	1.00
		Slope	0.16	Slope	1.00
				Seepage	0.02
72:					
Nizhoni	15	Very limited		Very limited	
		Depth to bedrock	1.00	Depth to hard bedrock	1.00
		Slope	0.16	Slope	1.00
				Seepage	0.02

Table 18.--Sewage Disposal--Continued

Map symbol and soil name	Pct. of map unit	Septic tank absorption fields		Sewage lagoons	
		Rating class and limiting features	Value	Rating class and limiting features	Value
72:					
Bamac	15	Very limited		Very limited	
		Too steep	1.00	Slope	1.00
		Depth to bedrock	0.25	Seepage	1.00
		Large stones content	0.01		
73:					
Levante family	65	Very limited		Very limited	
		Flooding	1.00	Flooding	1.00
		Filtering capacity	1.00	Seepage	1.00
				Slope	0.68
Levante family, frequently flooded	20	Very limited		Very limited	
		Flooding	1.00	Flooding	1.00
		Filtering capacity	1.00	Seepage	1.00
				Slope	0.68
74:					
Metuck	90	Very limited		Very limited	
		Depth to bedrock	1.00	Depth to hard bedrock	1.00
		Too steep	1.00	Depth to soft bedrock	1.00
				Slope	1.00
				Seepage	0.02

Table 19.--Source of Gravel and Sand

(The information in this table indicates the dominant soil condition but does not eliminate the need for onsite investigation. The ratings given for the thickest layer are for the thickest layer above and excluding the bottom layer. The numbers in the value columns range from 0.00 to 0.99. The greater the value, the greater the likelihood that the bottom layer or thickest layer of the soil is a source of sand or gravel. See text for further explanation of ratings in this table.)

Map symbol and soil name	Pct. of map unit	Potential source of gravel		Potential source of sand	
		Rating class	Value	Rating class	Value
69:					
Nomrah	55	Poor		Poor	
		Bottom layer	0.00	Bottom layer	0.00
		Thickest layer	0.00	Thickest layer	0.00
Plumasano	25	Poor		Fair	
		Bottom layer	0.00	Bottom layer	0.01
		Thickest layer	0.00	Thickest layer	0.05
Gladel	15	Poor		Fair	
		Bottom layer	0.00	Thickest layer	0.00
		Thickest layer	0.00	Bottom layer	0.01
70:					
Plumasano	50	Poor		Fair	
		Bottom layer	0.00	Bottom layer	0.04
		Thickest layer	0.00	Thickest layer	0.05
Tanoan family	20	Poor		Fair	
		Bottom layer	0.00	Thickest layer	0.02
		Thickest layer	0.00	Bottom layer	0.04
Gladel	15	Poor		Fair	
		Bottom layer	0.00	Thickest layer	0.00
		Thickest layer	0.00	Bottom layer	0.04
71:					
Gladel	70	Poor		Fair	
		Bottom layer	0.00	Thickest layer	0.00
		Thickest layer	0.00	Bottom layer	0.07
72:					
Nizhoni	15	Poor		Poor	
		Bottom layer	0.00	Bottom layer	0.00
		Thickest layer	0.00	Thickest layer	0.00
Bamac	15	Poor		Poor	
		Bottom layer	0.00	Bottom layer	0.00
		Thickest layer	0.00	Thickest layer	0.00
73:					
Levante family	65	Poor		Fair	
		Bottom layer	0.00	Thickest layer	0.07
		Thickest layer	0.00	Bottom layer	0.16
Levante family, frequently flooded	20	Poor		Fair	
		Bottom layer	0.00	Thickest layer	0.29
		Thickest layer	0.00	Bottom layer	0.30

Table 19.--Source of Gravel and Sand--Continued

Map symbol and soil name	Pct. of map unit	Potential source of gravel		Potential source of sand	
		Rating class	Value	Rating class	Value
74:					
Metuck--------------	90	Fair		Poor	
		Thickest layer	0.00	Bottom layer	0.00
		Bottom layer	0.47	Thickest layer	0.00

Table 20.--Source of Reclamation Material, Roadfill, and Topsoil

(The information in this table indicates the dominant soil condition but does not eliminate the need for onsite investigation. The numbers in the value columns range from 0.00 to 0.99. The smaller the value, the greater the limitation. See text for further explanation of ratings in this table.)

Map symbol and soil name	Pct. of map unit	Potential source of reclamation material: Rating class and limiting features	Value	Potential source of roadfill: Rating class and limiting features	Value	Potential source of topsoil: Rating class and limiting features	Value
69:							
Nomrah	55	Poor		Good		Good	
		Too alkaline	0.00				
		Organic matter content low	0.12				
		Carbonate content	0.61				
		Water erosion	0.99				
Plumasano	25	Fair		Good		Fair	
		Organic matter content low	0.12			Too sandy	0.68
		Too sandy	0.68				
Gladel	15	Poor		Poor		Poor	
		Droughty	0.00	Depth to bedrock	0.00	Depth to bedrock	0.00
		Depth to bedrock	0.00				
		Organic matter content low	0.12				
		Water erosion	0.99				
70:							
Plumasano	50	Poor		Good		Fair	
		Wind erosion	0.00			Too sandy	0.68
		Organic matter content low	0.12			Slope	0.84
		Too sandy	0.68				
		Water erosion	0.90				
Tanoan family	20	Poor		Poor		Poor	
		Too alkaline	0.00	Slope	0.00	Slope	0.00
		Carbonate content	0.00	Depth to bedrock	0.00	Carbonate content	0.75
		Droughty	0.04			Depth to bedrock	0.88
		Organic matter content low	0.12				
		Depth to bedrock	0.88				
Gladel	15	Poor		Poor		Poor	
		Droughty	0.00	Depth to bedrock	0.00	Depth to bedrock	0.00
		Depth to bedrock	0.00			Too sandy	0.78
		Too sandy	0.78				
71:							
Gladel	70	Poor		Poor		Poor	
		Droughty	0.00	Depth to bedrock	0.00	Depth to bedrock	0.00
		Depth to bedrock	0.00			Too sandy	0.78
		Too sandy	0.78			Slope	0.84

Table 20.--Source of Reclamation Material, Roadfill, and Topsoil--Continued

Map symbol and soil name	Pct. of map unit	Potential source of reclamation material: Rating class and limiting features	Value	Potential source of roadfill: Rating class and limiting features	Value	Potential source of topsoil: Rating class and limiting features	Value
72:							
Nizhoni	15	Poor		Poor		Poor	
		Wind erosion	0.00	Depth to bedrock	0.00	Depth to bedrock	0.00
		Droughty	0.00			Slope	0.84
		Depth to bedrock	0.00				
		Water erosion	0.37				
		Organic matter content low	0.50				
Bamac	15	Poor		Poor		Poor	
		Too sandy	0.00	Slope	0.00	Slope	0.00
		Wind erosion	0.00	Cobble content	0.41	Too sandy	0.00
		Droughty	0.00			Hard to reclaim (rock fragments)	0.00
		Organic matter content low	0.02			Rock fragments	0.00
		Cobble content	0.92				
73:							
Levante family	65	Poor		Good		Poor	
		Too sandy	0.00			Too sandy	0.00
		Wind erosion	0.00				
Levante family, frequently flooded	20	Poor		Good		Poor	
		Too sandy	0.00			Too sandy	0.00
		Wind erosion	0.00				
		Organic matter content low	0.50				
		Droughty	0.82				
74:							
Metuck	90	Poor		Poor		Poor	
		Droughty	0.00	Depth to bedrock	0.00	Slope	0.00
		Depth to bedrock	0.00	Slope	0.00	Rock fragments	0.00
						Depth to bedrock	0.00

Table 21.--Engineering Properties

(Absence of an entry indicates that the data were not estimated.)

Map symbol and soil name	Depth	USDA texture	Classification: Unified	Classification: AASHTO	Fragments: >10 inches	Fragments: 3-10 inches	Percentage passing sieve number--: 4	10	40	200	Liquid limit	Plasticity index
	In				Pct	Pct					Pct	
69:												
Nomrah----------	0-2	Very fine sandy loam, fine sandy loam, loam	CL-ML	A-4	0	0	93-100	92-100	86-100	43-57	20-35	3-12
	2-8	Loam, very fine sandy loam, fine sandy loam	CL	A-6	0	0	92-100	92-100	75-94	54-71	26-39	9-19
	8-13	Loam, very fine sandy loam, fine sandy loam	CL	A-6	0	0	92-100	92-100	73-92	53-69	26-39	9-19
	13-19	Fine sandy loam, very fine sandy loam, loam	CL	A-6	0	0	92-100	92-100	72-90	48-65	24-38	9-19
	19-39	Fine sandy loam, sandy loam, loam	CL	A-6	0	0	93-100	93-100	76-90	43-55	20-30	6-12
	39-48	Sandy loam, fine sandy loam, loam	SC	A-6	0	0	93-100	93-100	66-79	40-51	20-30	6-12
	48-59	Loam, sandy clay loam, fine sandy loam	SC	A-6	0	0	93-100	93-100	70-92	34-54	20-38	6-19
	59-65	Loam, sandy loam, fine sandy loam	CL	A-4	0	0	93-100	93-100	77-91	57-69	20-30	6-12
	65-79	Loam, sandy loam, fine sandy loam	CL	A-4	0	0	93-100	93-100	77-91	54-67	20-30	6-12
Plumasano-------	0-0	Slightly decomposed plant material	PT		0	0	100	100	100	100	---	---
	0-2	Fine sandy loam, very fine sandy loam	SC-SM	A-2-4	0	0	93-100	93-100	80-92	30-38	19-30	3-7
	2-6	Fine sandy loam, very fine sandy loam	SC-SM	A-4	0	0	93-100	93-100	82-97	30-41	21-33	6-12
	6-20	Fine sandy loam, very fine sandy loam	SC	A-4	0	0	93-100	93-100	81-95	27-38	20-30	6-12
	20-55	Fine sandy loam, very fine sandy loam	SC	A-4	0	0	93-100	93-100	82-97	28-38	20-30	6-12
	55-72	Loamy fine sand, fine sandy loam, sandy loam	SC-SM	A-4	0	0	93-100	93-100	83-97	37-47	18-27	3-9
Gladel----------	0-2	Fine sandy loam	SC-SM	A-4	0	0	93-100	93-100	81-100	35-51	18-35	2-12
	2-8	Fine sandy loam, gravelly fine sandy loam, sandy loam	SC-SM	A-4	0	0	56-93	54-92	48-92	20-47	17-31	2-12
	8-16	Fine sandy loam, gravelly sandy loam	SC-SM	A-4	0	0	56-93	54-92	46-91	19-45	16-30	2-12
	16-26	Bedrock			---	---	---	---	---	---	---	---

Table 21.--Engineering Properties--Continued

Map symbol and soil name	Depth	USDA texture	Classification		Fragments		Percentage passing sieve number--				Liquid limit	Plasticity index
			Unified	AASHTO	>10 inches	3-10 inches	4	10	40	200		
	In				Pct	Pct					Pct	
70:												
Plumasano-------	0-2	Fine sandy loam, very fine sandy loam, loamy fine sand	SC-SM	A-2-4	0	0	93-100	92-100	84-97	21-28	19-30	3-7
	2-15	Fine sandy loam, very fine sandy loam	CL-ML	A-4	0	0	93-100	92-100	90-100	42-53	21-31	6-12
	15-19	Fine sandy loam, very fine sandy loam	CL	A-4	0	0	93-100	93-100	88-100	41-53	20-30	6-12
	19-35	Fine sandy loam, very fine sandy loam	CL	A-4	0	0	93-100	93-100	89-100	41-52	20-30	6-12
	35-56	Fine sandy loam, very fine sandy loam	SC-SM	A-4	0	0	93-100	93-100	83-98	30-40	20-30	6-12
	56-66	Sandy loam, loamy fine sand	SC-SM	A-4	0	0	93-100	93-100	87-100	29-39	18-27	3-9
	66-76	Bedrock			---	---	---	---	---	---	---	---
Tanoan family---	0-2	Gravelly loam, gravelly fine sandy loam	CL	A-6	0	0	81-100	80-100	61-93	42-69	20-38	6-19
	2-12	Fine sandy loam	SC	A-6	0	0	100	100	87-97	33-43	20-32	6-13
	12-26	Sandy loam, fine sandy loam	SC	A-4	0	0	100	100	87-97	34-44	20-32	6-13
	26-35	Fine sandy loam, sandy loam	SC-SM	A-2-4	0	0	75-93	74-93	54-80	25-44	16-30	2-12
	35-44	Bedrock			---	---	---	---	---	---	---	---
Gladel----------	0-3	Fine sandy loam	SC-SM	A-4	0	0	93-100	93-100	79-98	27-42	18-35	2-12
	3-7	Sandy loam, fine sandy loam	SC-SM	A-4	0	0	93-100	93-100	79-98	29-44	17-33	2-12
	7-11	Fine sandy loam, gravelly fine sandy loam	SC-SM	A-2-4	0	0	56-93	54-92	46-91	15-38	17-44	2-12
	11-13	Fine sandy loam, gravelly fine sandy loam	SC-SM	A-2-4	0	0	56-93	54-92	46-91	15-38	16-30	2-12
	13-23	Bedrock			---	---	---	---	---	---	---	---

Table 21.--Engineering Properties--Continued

Map symbol and soil name	Depth	USDA texture	Classification: Unified	Classification: AASHTO	Fragments: >10 inches	Fragments: 3-10 inches	Percentage passing sieve number--: 4	10	40	200	Liquid limit	Plasticity index
	In				Pct	Pct					Pct	
71:												
Gladel----------	0-1	Slightly decomposed plant material	PT		---	---	100	100	100	100	---	---
	1-5	Fine sandy loam	SC-SM	A-4	0	0	93-100	93-100	79-98	26-41	18-35	2-12
	5-7	Fine sandy loam, gravelly fine sandy loam, sandy loam	SC	A-4	0	0	79-100	78-100	63-94	19-37	17-31	2-12
	7-10	Fine sandy loam, gravelly sandy loam, cemented sandy loam	SC-SM	A-2-4	0	0	79-93	78-92	52-74	19-35	16-30	2-12
	10-20	Bedrock			---	---	---	---	---	---	---	---
72:												
Nizhoni---------	0-3	Fine sandy loam, loamy fine sand	SM	A-4	0	0	86-100	85-100	80-100	30-42	17-26	2-7
	3-8	Fine sandy loam, sandy loam, very fine sandy loam	CL-ML	A-4	0	0	86-100	85-100	81-100	47-62	18-27	3-9
	8-18	Bedrock			---	---	---	---	---	---	---	---
Bamac-----------	0-4	Loamy sand, gravelly loamy fine sand	SM	A-2-4	0	0-20	54-81	51-80	46-79	13-28	0-24	NP-6
	4-22	Very cobbly sandy loam, extremely gravelly sand	GC-GM	A-1-a	0	13-26	33-66	30-64	23-55	3-13	0-23	NP-6
	22-60	Extremely gravelly sand, very cobbly sand	GC-GM	A-1-a	0	26-38	38-77	34-75	26-65	3-13	0-23	NP-6
	60-70	Bedrock			---	---	---	---	---	---	---	---
73:												
Levante family--	0-5	Loamy fine sand	SM	A-2-4	0	0	92-100	92-100	84-98	23-32	0-31	NP-6
	5-10	Loamy fine sand	SM	A-2-4	0	0	81-100	80-100	71-98	20-33	0-26	NP-6
	10-35	Loamy fine sand	SM	A-2-4	0	0	81-100	80-100	70-97	16-30	0-26	NP-6
	35-52	Loamy fine sand, fine sand	SM	A-2-4	0	0	81-100	80-100	73-96	10-18	0-23	NP-3
	52-71	Loamy fine sand, fine sand	SM	A-2-4	0	0	58-100	56-100	52-97	8-19	0-23	NP-3
	71-80	Fine sand, loamy fine sand	SM	A-2-4	0	0	58-100	56-100	52-96	8-19	0-23	NP-3

Table 21.--Engineering Properties--Continued

Map symbol and soil name	Depth	USDA texture	Classification: Unified	Classification: AASHTO	Fragments: >10 inches	Fragments: 3-10 inches	Percentage passing sieve number--: 4	Percentage passing sieve number--: 10	Percentage passing sieve number--: 40	Percentage passing sieve number--: 200	Liquid limit	Plasticity index
	In				Pct	Pct					Pct	
73:												
Levante family, frequently flooded--------	0-2	Fine sand, loamy fine sand, coarse sand, sand	SM	A-2-4	0	0	93-100	93-100	83-99	15-25	0-24	NP-6
	2-7	Fine sand	SM	A-2-4	0	0	92-100	92-100	83-100	12-23	0-31	NP-6
	7-9	Loamy fine sand	SM	A-2-4	0	0	92-100	92-100	78-94	19-30	0-31	NP-6
	9-17	Sand	SP-SM		0	0-7	80-100	79-100	60-81	6-12	0-21	NP-3
	17-30	Fine sand	SM		0	0-14	80-100	79-100	73-99	13-24	0-24	NP-6
	30-41	Fine sand	SM		0	0-14	80-100	79-100	73-97	9-17	0-21	NP-3
	41-61	Sand	SP		0	0-38	58-100	56-100	42-80	4-12	0-21	NP-3
	61-65	Fine sand	SM		0	0-38	58-100	56-100	52-98	6-16	0-21	NP-3
74:												
Metuck----------	0-2	Very gravelly sandy loam	GC	A-2-4	0	0	36-59	32-57	24-46	11-24	22-35	6-12
	2-5	Very gravelly loam, extremely gravelly loam	GC	A-2-4	0	0	27-59	24-57	19-51	12-35	22-33	6-12
	5-7	Bedrock			---	---	---	---	---	---	---	---
	7-17	Bedrock			---	---	---	---	---	---	---	---

Table 22.--Ponds and Embankments

(The information in this table indicates the dominant soil condition but does not eliminate the need for onsite investigation. The numbers in the value columns range from 0.01 to 1.00. The larger the value, the greater the limitation. See text for further explanation of ratings in this table.)

Map symbol and soil name	Pct. of map unit	Pond reservoir areas		Embankments, dikes, and levees		Aquifer-fed excavated ponds	
		Rating class and limiting features	Value	Rating class and limiting features	Value	Rating class and limiting features	Value
69:							
Nomrah	55	Very limited		Somewhat limited		Very limited	
		Seepage	1.00	Piping	0.88	Depth to water	1.00
		Slope	0.08				
Plumasano	25	Very limited		Somewhat limited		Very limited	
		Seepage	1.00	Seepage	0.05	Depth to water	1.00
		Slope	0.08				
Gladel	15	Very limited		Very limited		Very limited	
		Depth to bedrock	1.00	Thin layer	1.00	Depth to water	1.00
		Slope	0.68	Seepage	0.01		
		Seepage	0.19				
70:							
Plumasano	50	Very limited		Somewhat limited		Very limited	
		Seepage	1.00	Seepage	0.05	Depth to water	1.00
		Slope	1.00				
Tanoan family	20	Very limited		Somewhat limited		Very limited	
		Seepage	1.00	Thin layer	0.71	Depth to water	1.00
		Slope	1.00	Seepage	0.04		
		Depth to bedrock	0.71				
Gladel	15	Very limited		Very limited		Very limited	
		Depth to bedrock	1.00	Thin layer	1.00	Depth to water	1.00
		Slope	0.32	Seepage	0.04		
		Seepage	0.19				
71:							
Gladel	70	Very limited		Very limited		Very limited	
		Depth to bedrock	1.00	Thin layer	1.00	Depth to water	1.00
		Slope	1.00	Seepage	0.07		
		Seepage	0.19				
72:							
Nizhoni	15	Very limited		Very limited		Very limited	
		Depth to bedrock	1.00	Thin layer	1.00	Depth to water	1.00
		Slope	1.00				
Bamac	15	Very limited		Somewhat limited		Very limited	
		Seepage	1.00	Seepage	0.82	Depth to water	1.00
		Slope	1.00	Large stones content	0.01		

Table 22.--Ponds and Embankments--Continued

Map symbol and soil name	Pct. of map unit	Pond reservoir areas		Embankments, dikes, and levees		Aquifer-fed excavated ponds	
		Rating class and limiting features	Value	Rating class and limiting features	Value	Rating class and limiting features	Value
73:							
Levante family------	65	Very limited		Somewhat limited		Very limited	
		Seepage	1.00	Seepage	0.16	Depth to water	1.00
		Slope	0.32				
Levante family, frequently flooded-	20	Very limited		Somewhat limited		Very limited	
		Seepage	1.00	Seepage	0.75	Depth to water	1.00
		Slope	0.32				
74:							
Metuck--------------	90	Very limited		Very limited		Very limited	
		Slope	1.00	Thin layer	1.00	Depth to water	1.00
		Depth to bedrock	1.00	Seepage	0.47		

Table 23.--Physical Soil Properties

(Entries under "Erosion factors--T" apply to the entire profile. Entries under "Wind erodibility group" and "Wind erodibility index" apply only to the surface layer. Absence of an entry indicates that data were not estimated.)

Map symbol and soil name	Depth	Sand	Silt	Clay	Moist bulk density	Permea- bility (Ksat)	Available water capacity	Linear extensi- bility	Organic matter	Erosion factors			Wind erodi- bility group	Wind erodi- bility index
										Kw	Kf	T		
	In	Pct	Pct	Pct	g/cc	In/hr	In/in	Pct	Pct					
69:														
Nomrah--------------	0-2	50-77	5-30	7-18	1.30-1.60	2-6	0.13-0.15	0.0-2.9	1.0-3.0	.37	.37	5	3	86
	2-8	36-53	20-49	15-27	1.30-1.50	0.6-2	0.11-0.14	0.0-2.9	0.5-1.0	.37	.37			
	8-13	36-53	20-49	15-27	1.30-1.50	0.6-2	0.11-0.14	0.0-2.9	0.5-1.0	.32	.32			
	13-19	40-53	25-45	15-27	1.30-1.50	0.6-2	0.10-0.14	0.0-2.9	0.0-0.5	.32	.32			
	19-39	52-70	12-38	10-18	1.45-1.60	2-6	0.06-0.12	0.0-2.9	0.0-0.5	.32	.32			
	39-48	50-70	12-37	10-18	1.45-1.60	2-6	0.06-0.12	0.0-2.9	0.0-0.5	.28	.28			
	48-59	52-67	6-38	10-27	1.45-1.60	2-6	0.09-0.12	0.0-2.9	0.0-0.5	.24	.24			
	59-65	35-53	29-50	10-18	1.45-1.60	2-6	0.09-0.12	0.0-2.9	0.0-0.5	.43	.43			
	65-79	40-53	29-50	10-18	1.45-1.60	2-6	0.09-0.12	0.0-2.9	0.0-0.5	.43	.43			
Plumasano-----------	0-0	---	---	0-0	---	6-20	---	---	100-100	---	---	5	3	86
	0-2	65-77	11-20	6-12	1.40-1.55	2-6	0.09-0.12	0.0-2.9	1.0-3.0	.20	.20			
	2-6	65-78	4-25	10-18	1.40-1.55	2-6	0.09-0.12	0.0-2.9	0.5-2.0	.20	.20			
	6-20	65-78	4-25	10-18	1.45-1.60	2-6	0.08-0.11	0.0-2.9	0.0-0.8	.20	.20			
	20-55	65-78	4-25	10-18	1.45-1.60	2-6	0.08-0.11	0.0-2.9	0.0-0.8	.24	.24			
	55-72	65-75	11-28	7-14	1.45-1.60	2-6	0.08-0.11	0.0-2.9	0.0-0.8	.32	.32			
Gladel--------------	0-2	65-73	9-30	5-18	1.40-1.55	2-6	0.09-0.12	0.0-2.9	1.0-3.0	.28	.28	1	3	86
	2-8	65-73	9-30	5-18	1.35-1.70	2-6	0.10-0.12	0.0-2.9	0.5-1.0	.37	.37			
	8-16	65-73	9-30	5-18	1.35-1.70	2-6	0.10-0.12	0.0-2.9	0.0-0.5	.32	.32			
	16-26	---	---	---	---	0.00-1	---	---	---	---	---			
70:														
Plumasano-----------	0-2	80-86	2-14	6-12	1.30-1.50	2-6	0.14-0.16	0.0-2.9	1.0-3.0	.15	.15	5	2	134
	2-15	65-78	4-26	10-18	1.40-1.50	2-6	0.11-0.13	0.0-2.9	0.5-1.0	.43	.43			
	15-19	65-78	4-25	10-18	1.45-1.60	2-6	0.08-0.11	0.0-2.9	0.0-0.8	.43	.43			
	19-35	65-78	4-25	10-18	1.45-1.60	2-6	0.08-0.11	0.0-2.9	0.0-0.8	.43	.43			
	35-56	65-80	2-25	10-18	1.45-1.60	2-6	0.08-0.11	0.0-2.9	0.0-0.8	.24	.24			
	56-66	75-85	4-18	7-14	1.50-1.65	2-6	0.10-0.12	0.0-2.9	0.0-0.8	.32	.32			
	66-76	---	---	---	---	0.00-1	---	---	---	---	---			

Table 23.--Physical Soil Properties--Continued

Map symbol and soil name	Depth	Sand	Silt	Clay	Moist bulk density	Permea- bility (Ksat)	Available water capacity	Linear extensi- bility	Organic matter	Erosion factors Kw	Erosion factors Kf	Erosion factors T	Wind erodi- bility group	Wind erodi- bility index
	In	Pct	Pct	Pct	g/cc	In/hr	In/in	Pct	Pct					
70:														
Tanoan family-------	0-2	40-53	20-50	10-27	1.45-1.75	0.6-2	0.08-0.12	0.0-2.9	0.0-0.8	.24	.24	2	5	56
	2-12	65-75	5-25	10-20	1.50-1.60	2-6	0.09-0.11	0.0-2.9	0.0-0.8	.24	.24			
	12-26	65-75	5-25	10-20	1.50-1.60	2-6	0.09-0.11	0.0-2.9	0.0-0.8	.24	.24			
	26-35	65-72	10-30	5-18	1.45-1.70	2-6	0.08-0.11	0.0-2.9	0.0-0.8	.32	.32			
	35-44	---	---	---	---	0.00-1	---	---	---	---	---			
Gladel--------------	0-3	65-78	4-30	5-18	1.40-1.55	2-6	0.09-0.12	0.0-2.9	1.0-3.0	.24	.24	1	3	86
	3-7	65-75	7-30	5-18	1.40-1.55	2-6	0.09-0.12	0.0-2.9	0.5-2.0	.24	.24			
	7-11	65-75	7-30	5-18	1.35-1.70	2-6	0.10-0.12	0.0-2.9	0.5-7.0	.17	.28			
	11-13	65-75	7-30	5-18	1.35-1.70	2-6	0.10-0.12	0.0-2.9	0.0-0.5	.15	.28			
	13-23	---	---	---	---	0.00-1	---	---	---	---	---			
71:														
Gladel--------------	0-1	---	---	0-0	---	6-20	---	---	100-100	---	---	1	3	86
	1-5	65-77	5-30	5-18	1.40-1.55	2-6	0.09-0.12	0.0-2.9	1.0-3.0	.20	.20			
	5-7	65-77	5-30	5-18	1.35-1.70	2-6	0.10-0.12	0.0-2.9	0.5-1.0	.24	.24			
	7-10	65-75	7-30	5-18	1.35-1.70	2-6	0.10-0.12	0.0-2.9	0.0-0.5	.24	.24			
	10-20	---	---	---	---	0.00-1	---	---	---	---	---			
72:														
Nizhoni-------------	0-3	75-85	3-20	5-12	1.40-1.50	2-6	0.12-0.14	0.0-2.9	0.5-1.0	.32	.32	1	2	134
	3-8	60-70	16-33	7-14	1.40-1.50	2-6	0.12-0.14	0.0-2.9	0.2-0.8	.55	.55			
	8-18	---	---	---	---	0.00-1	---	---	---	---	---			
Bamac---------------	0-4	75-90	0-15	1-10	1.55-1.65	6-20	0.02-0.03	0.0-2.9	0.5-1.0	.15	.24	5	2	134
	4-22	75-95	0-15	1-10	1.55-1.65	6-20	0.02-0.04	0.0-2.9	0.0-0.5	.02	.10			
	22-60	75-97	0-16	1-10	1.55-1.65	6-20	0.02-0.04	0.0-2.9	0.0-0.5	.02	.10			
	60-70	---	---	---	---	0.00-1	---	---	---	---	---			
73:														
Levante family------	0-5	78-88	3-20	3-10	1.25-1.45	6-20	0.11-0.15	0.0-2.9	2.0-4.0	.10	.10	5	2	134
	5-10	78-88	3-20	1-10	1.55-1.70	6-20	0.05-0.11	0.0-2.9	0.0-2.0	.24	.24			
	10-35	78-88	3-20	1-10	1.55-1.70	6-20	0.05-0.11	0.0-2.9	0.0-2.0	.20	.20			
	35-52	88-98	1-12	1-6	1.55-1.70	6-20	0.05-0.11	0.0-2.9	0.0-2.0	.10	.10			
	52-71	88-98	1-12	1-6	1.55-1.70	6-20	0.05-0.11	0.0-2.9	0.0-2.0	.15	.15			
	71-80	88-98	1-12	1-6	1.55-1.70	6-20	0.05-0.11	0.0-2.9	0.0-2.0	.15	.15			

Table 23.--Physical Soil Properties--Continued

Map symbol and soil name	Depth	Sand	Silt	Clay	Moist bulk density	Permea- bility (Ksat)	Available water capacity	Linear extensi- bility	Organic matter	Erosion factors Kw	Erosion factors Kf	Erosion factors T	Wind erodi- bility group	Wind erodi- bility index
	In	Pct	Pct	Pct	g/cc	In/hr	In/in	Pct	Pct					
73:														
Levante family,														
frequently flooded-	0-2	75-90	2-19	1-10	1.50-1.60	6-20	0.06-0.08	0.0-2.9	0.0-1.0	.15	.15	5	2	134
	2-7	80-95	2-19	1-10	1.25-1.40	6-20	0.11-0.16	0.0-2.9	2.0-4.0	.10	.10			
	7-9	80-95	2-19	1-10	1.25-1.40	6-20	0.11-0.16	0.0-2.9	2.0-4.0	.17	.17			
	9-17	80-98	1-11	1-6	1.50-1.60	6-20	0.05-0.08	0.0-2.9	0.0-1.0	.05	.05			
	17-30	78-98	2-19	3-10	1.50-1.60	6-20	0.05-0.08	0.0-2.9	0.0-1.0	.15	.15			
	30-41	88-98	1-10	1-6	1.50-1.60	6-20	0.05-0.08	0.0-2.9	0.0-1.0	.15	.15			
	41-61	88-98	1-10	1-6	1.50-1.60	6-20	0.05-0.08	0.0-2.9	0.0-1.0	.05	.05			
	61-65	88-98	1-10	1-6	1.50-1.60	6-20	0.05-0.08	0.0-2.9	0.0-1.0	.10	.10			
74:														
Metuck--------------	0-2	65-75	7-25	10-18	1.60-1.70	2-6	0.10-0.13	0.0-2.9	1.0-3.0	.10	.24	1	6	48
	2-5	42-50	32-48	10-18	1.60-1.70	0.6-2	0.13-0.19	0.0-2.9	0.8-2.0	.05	.37			
	5-7	---	---	---	---	1-14	---	---	---	---	---			
	7-17	---	---	---	---	0.00-1	---	---	---	---	---			

Table 24.--Erosion Properties of Soils

(Entries under "Erosion factors" apply to the entire profile. Entries under "Wind erodibility group" and "Wind erodibility index" apply only to the surface layer)

Map symbol and soil name	Depth	Erosion factors			Wind erodi-bility group	Wind erodi-bility index
		Kw	Kf	T		
	In					
69:						
Nomrah	0-2	.37	.37	5	3	86
	2-8	.37	.37			
	8-13	.32	.32			
	13-19	.32	.32			
	19-39	.32	.32			
	39-48	.28	.28			
	48-59	.24	.24			
	59-65	.43	.43			
	65-79	.43	.43			
Plumasano	0-0	---	---	5	3	86
	0-2	.20	.20			
	2-6	.20	.20			
	6-20	.20	.20			
	20-55	.24	.24			
	55-72	.32	.32			
Gladel	0-2	.28	.28	1	3	86
	2-8	.37	.37			
	8-16	.32	.32			
	16-26	---	---			
70:						
Plumasano	0-2	.15	.15	5	2	134
	2-15	.43	.43			
	15-19	.43	.43			
	19-35	.43	.43			
	35-56	.24	.24			
	56-66	.32	.32			
	66-76	---	---			
Tanoan Family	0-2	.24	.24	2	5	56
	2-12	.24	.24			
	12-26	.24	.24			
	26-35	.32	.32			
	35-44	---	---			
Gladel	0-3	.24	.24	1	3	86
	3-7	.24	.24			
	7-11	.17	.28			
	11-13	.15	.28			
	13-23	---	---			
71:						
Gladel	0-1	---	---	1	3	86
	1-5	.20	.20			
	5-7	.24	.24			
	7-10	.24	.24			
	10-20	---	---			

Table 24.--Erosion Properties of Soils--Continued

(Entries under "Erosion factors" apply to the entire profile. Entries under "Wind erodibility group" and "Wind erodibility index" apply only to the surface layer)

Map symbol and soil name	Depth	Erosion factors			Wind erodi- bility group	Wind erodi- bility index
		Kw	Kf	T		
	In					
72:						
Nizhoni-------------------------------	0-3	.32	.32	1	2	134
	3-8	.55	.55			
	8-18	---	---			
Bamac---------------------------------	0-4	.15	.24	5	2	134
	4-22	.02	.10			
	22-60	.02	.10			
	60-70	---	---			
73:						
Levante Family------------------------	0-5	.10	.10	5	2	134
	5-10	.24	.24			
	10-35	.20	.20			
	35-52	.10	.10			
	52-71	.15	.15			
	71-80	.15	.15			
Levante Family, frequently flooded-----	0-2	.15	.15	5	2	134
	2-7	.10	.10			
	7-9	.17	.17			
	9-17	.05	.05			
	17-30	.15	.15			
	30-41	.15	.15			
	41-61	.05	.05			
	61-65	.10	.10			
74:						
Metuck--------------------------------	0-2	.10	.24	1	6	48
	2-5	.05	.37			
	5-7	---	---			
	7-17	---	---			

Table 25.--Chemical Soil Properties

(Absence of an entry indicates that data were not estimated.)

Map symbol and soil name	Depth	Cation exchange capacity	Soil reaction	Calcium carbonate	Gypsum	Salinity	Sodium adsorption ratio
	In	meq/100 g	pH	Pct	Pct	mmhos/cm	
69:							
Nomrah---------------	0-2	6.4-16	7.4-8.4	0-5	0	0.0-1.0	0-2
	2-8	12-22	7.9-8.4	0-5	0	0.0-1.0	0-2
	8-13	12-22	7.9-8.4	0-5	0	0.0-1.0	0-2
	13-19	11-21	7.9-9.0	5-15	0	0.0-1.0	0-2
	19-39	7.6-15	7.9-9.0	15-30	0	0.0-1.0	0-8
	39-48	7.6-15	8.5-9.0	15-30	0	0.0-2.0	2-13
	48-59	7.6-21	8.5-9.0	15-30	0	0.0-2.0	2-13
	59-65	7.6-15	8.5-9.0	15-30	0	0.0-2.0	2-13
	65-79	7.6-15	8.5-9.0	15-30	0	0.0-2.0	2-13
Plumasano------------	0-0	---	---	---	---	---	---
	0-2	5.6-11	7.9-8.4	0-2	0	0.0-1.0	0-2
	2-6	8.6-16	7.9-8.4	0-10	0	0.0-1.0	0-2
	6-20	7.6-15	7.9-8.4	10-15	0	0.0-4.0	0-8
	20-55	7.6-15	7.9-9.0	10-15	0	0.0-4.0	0-8
	55-72	5.5-12	7.9-9.0	5-15	0	0.0-4.0	0-8
Gladel---------------	0-2	4.8-16	7.9-8.4	0-5	0	0.0-2.0	0
	2-8	4.6-15	7.9-8.4	0-10	0	0.0-2.0	0
	8-16	4.1-15	7.9-8.4	5-15	0	0.0-2.0	0
	16-26	---	---	---	---	---	---
70:							
Plumasano------------	0-2	5.6-11	7.9-8.4	0-2	0	0.0-1.0	0-2
	2-15	8.6-15	7.9-8.4	0-10	0	0.0-1.0	0-2
	15-19	7.6-15	7.9-8.4	5-15	0	0.0-4.0	0-2
	19-35	7.6-15	7.9-8.4	5-15	0	0.0-4.0	0-8
	35-56	7.6-15	7.9-9.0	5-15	0	0.0-4.0	0-8
	56-66	5.5-12	7.9-9.0	5-15	0	0.0-4.0	0-8
	66-76	---	---	---	---	---	---
Tanoan family--------	0-2	7.6-22	7.9-9.0	15-50	0	0.0-2.0	0-4
	2-12	7.6-16	7.9-9.0	15-50	0	0.0-2.0	0-4
	12-26	7.6-16	7.9-9.0	15-50	0	0.0-2.0	0-8
	26-35	4.1-15	7.9-9.0	10-50	0	0.0-2.0	0-8
	35-44	---	---	---	---	---	---
Gladel---------------	0-3	4.8-16	7.4-8.4	0-5	0	0.0-2.0	0
	3-7	4.6-16	7.9-8.4	0-5	0	0.0-2.0	0
	7-11	4.6-16	7.9-8.4	10-15	0	0.0-2.0	0
	11-13	4.1-15	7.9-8.4	10-15	0	0.0-2.0	0
	13-23	---	---	---	---	---	---
71:							
Gladel---------------	0-1	---	---	---	---	---	---
	1-5	4.8-16	7.9-8.4	0-5	0	0.0-2.0	0
	5-7	4.6-15	7.9-8.4	5-15	0	0.0-2.0	0
	7-10	4.1-15	7.9-8.4	5-15	0	0.0-2.0	0
	10-20	---	---	---	---	---	---

Table 25.--Chemical Soil Properties--Continued

Map symbol and soil name	Depth	Cation exchange capacity	Soil reaction	Calcium carbonate	Gypsum	Salinity	Sodium adsorption ratio
	In	meq/100 g	pH	Pct	Pct	mmhos/cm	
72:							
Nizhoni----------------	0-3	4.6-10	7.4-8.4	0-5	0	0.0-1.0	0
	3-8	6.1-12	7.9-8.4	5-15	0	0.0-1.0	0
	8-18	---	---	---	---	---	---
Bamac------------------	0-4	1.0-7.8	7.9-8.4	0-5	0	0.0-1.0	0
	4-22	0.8-7.4	7.9-8.4	0-5	0	0.0-1.0	0
	22-60	0.8-7.4	7.9-8.4	0-5	0	0.0-1.0	0
	60-70	---	---	---	---	---	---
73:							
Levante family-------	0-5	2.9-8.7	7.9-8.4	0-5	0	0.0-1.0	0
	5-10	0.8-8.2	7.9-9.0	0-10	0	0.0-2.0	0
	10-35	0.8-8.2	7.9-9.0	0-10	0	0.0-2.0	0
	35-52	0.8-5.3	7.9-9.0	0-10	0	0.0-2.0	0
	52-71	0.8-5.3	7.9-9.0	0-10	0	0.0-2.0	0
	71-80	0.8-5.3	7.9-9.0	0-10	0	0.0-2.0	0
Levante family, frequently flooded--	0-2	0.8-7.8	7.9-8.4	0-2	0	0.0-1.0	0
	2-7	1.1-8.7	7.9-8.4	0-2	0	0.0-1.0	0
	7-9	1.1-8.7	7.9-8.4	0-2	0	0.0-1.0	0
	9-17	0.8-5.0	7.9-9.0	0-5	0	0.0-2.0	0
	17-30	2.0-7.8	7.9-9.0	0-5	0	0.0-2.0	0
	30-41	0.8-5.0	7.9-9.0	0-5	0	0.0-2.0	0
	41-61	0.8-5.0	7.9-9.0	0-5	0	0.0-2.0	0
	61-65	0.8-5.0	7.9-9.0	0-5	0	0.0-2.0	0
74:							
Metuck-----------------	0-2	8.9-16	7.9-8.4	1-10	0-2	0.0-1.0	0
	2-5	8.8-16	7.9-8.4	5-20	0-2	0.0-1.0	0
	5-7	---	---	---	---	---	---
	7-17	---	---	---	---	---	---

Table 26.--Water Features

(Depths of layers are in feet. See text for definitions of terms used in this table. Estimates of the frequency of ponding and flooding apply to the whole year rather than to individual months. Absence of an entry indicates that the feature is not a concern or that data were not estimated.)

Map symbol and soil name	Hydro-logic group	Month	Ponding	Flooding	
			Frequency	Duration	Frequency
69:					
Nomrah	B				
		Jan-Dec	None	---	None
Plumasano	B				
		Jan-Dec	None	---	None
Gladel	D				
		Jan-Dec	None	---	None
70:					
Plumasano	C				
		Jan-Dec	None	---	None
Tanoan Family	C				
		Jan-Dec	None	---	None
Gladel	D				
		Jan-Dec	None	---	None
71:					
Gladel	D				
		Jan-Dec	None	---	None
72:					
Nizhoni	D				
		Jan-Dec	None	---	None
Bamac	A				
		Jan-Dec	None	---	None
73:					
Levante Family	A				
		July	None	Very brief	Occasional
		August	None	Very brief	Occasional
		September	None	Very brief	Occasional
		October	None	Very brief	Occasional
Levante Family, frequently flooded	A				
		July	None	Brief	Frequent
		August	None	Brief	Frequent
		September	None	Brief	Frequent
		October	None	Brief	Frequent
74:					
Metuck	D				
		Jan-Dec	None	---	None

Table 27.--Soil Features

(See text for definitions of terms used in this table. Absence of an entry indicates that data were not populated. Components with no data in all columns will not display.)

Map symbol and soil name	Restrictive layer				Potential for frost action	Risk of corrosion	
	Kind	Depth to top	Thickness	Hardness		Uncoated steel	Concrete
		In	In				
69:							
Nomrah	No restriction	---	---	---	Moderate	High	Low
Plumasano	No restriction	---	---	---	Moderate	High	Low
Gladel	Lithic bedrock	9-20	---	Indurated	Moderate	High	Low
70:							
Plumasano	Lithic bedrock	60-80	---	Indurated	Moderate	High	Low
Tanoan Family	Lithic bedrock	20-60	---	Indurated	Moderate	High	Low
Gladel	Lithic bedrock	9-20	---	Indurated	Moderate	Moderate	Low
71:							
Gladel	Lithic bedrock	9-20	---	Indurated	Moderate	Moderate	Low
72:							
Nizhoni	Lithic bedrock	4-20	---	Indurated	Moderate	Moderate	Low
73:							
Levante Family	No restriction	---	---	---	Low	High	Low
Levante Family, frequently flooded	No restriction	---	---	---	Low	High	Low
74:							
Metuck	Paralithic bedrock	4-10	2-10	Moderately cemented	Moderate	Moderate	Low
	Lithic bedrock	6-20		Indurated			

Table 28.-- Landscape, Parent Material and Ecosite ID

Map symbol and soil name	Percent of map unit	Slope	Elevation	MAP	Landform	Geology	Parent material	Ecological site
	Pct	Pct	Ft	In				
69:								
Nomrah	55	2-6	5800-6700	12-15	Mesa	Cedar Mesa Formation Sandstone (Permian)	Eolian deposits derived from sandstone	Upland Loam (Big Sagebrush), R036XY306UT
Plumasano	25	2-6	5800-6700	12-15	Mesa	Cedar Mesa Formation Sandstone (Permian)	Eolian deposits derived from sandstone	Upland Loam (Pinyon/Utah Juniper), R036XY307UT
Gladel	15	5-8	5800-6700	12-15	Mesa	Cedar Mesa Formation Sandstone (Permian)	Eolian deposits derived from sandstone	Upland Shallow Loam (Pinyon/Utah Juniper), R036XY315UT
70:								
Plumasano	50	5-15	5800-6700	12-15	Mesa	Cedar Mesa Formation Sandstone (Permian)	Eolian deposits derived from sandstone	Upland Loam (Pinyon/Utah Juniper), R036XY307UT
Tanoan family	20	20-50	5800-6700	12-15	Break	Cedar Mesa Formation Sandstone (Permian)	Eolian deposits derived from sandstone	Upland Dissected Slope (Pinyon/Utah Juniper), R036XY302UT
Gladel	15	2-8	5800-6700	12-15	Mesa	Cedar Mesa Formation Sandstone (Permian)	Eolian deposits derived from sandstone	Upland Shallow Loam (Pinyon/Utah Juniper), R036XY315UT
71:								
Gladel	70	5-15	5800-6700	12-15	Mesa Structural bench	Cedar Mesa Formation Sandstone (Permian)	Eolian deposits derived from sandstone	Upland Shallow Loam (Pinyon/Utah Juniper), R036XY315UT
72:								
Nizhoni	15	5-15	5600-6600	12-15	Ledge Structural bench	Cedar Mesa Formation Sandstone (Permian)	Eolian deposits derived from sandstone	Upland Shallow Loam (Littleleaf Mountain Mahogany), R036XY316UT
Bamac	15	20-60	5600-6600	12-15	Escarpment Talus slope	Cedar Mesa Formation Sandstone (Permian)	Colluvium derived from sandstone	Upland Very Steep Stony Loam (Pinyon/Utah Juniper), R036XY328UT

Table 28.--Landscape, Parent Material and Ecosite ID--Continued

Map symbol and soil name	Percent of map unit	Slope	Elevation	MAP	Landform	Geology	Parent material	Ecological site
	Pct	Pct	Ft	In				
73:								
Levante family-----	65	0-15	5600-6200	12-15	High terrace	Quaternary Alluvium	Alluvium derived from sandstone	Loamy Terrace (Basin Big Sagebrush/Oakbrush), R036XY011UT
Levante family, frequently flooded	20	0-6	5600-6200	12-15	Flood-plain step	Quaternary Alluvium	Alluvium derived from sandstone	Semi-wet Fresh Streambank (Fremont Cottonwood), R036XY013UT
74:								
Metuck-------------	90	25-65	5899-6600	12-15	Escarpment Talus slope	Organ Rock Sandstone (Permian)	Colluvium derived from sandstone	Upland Very Steep Stony Loam (Pinyon/Utah Juniper), R036XY328UT

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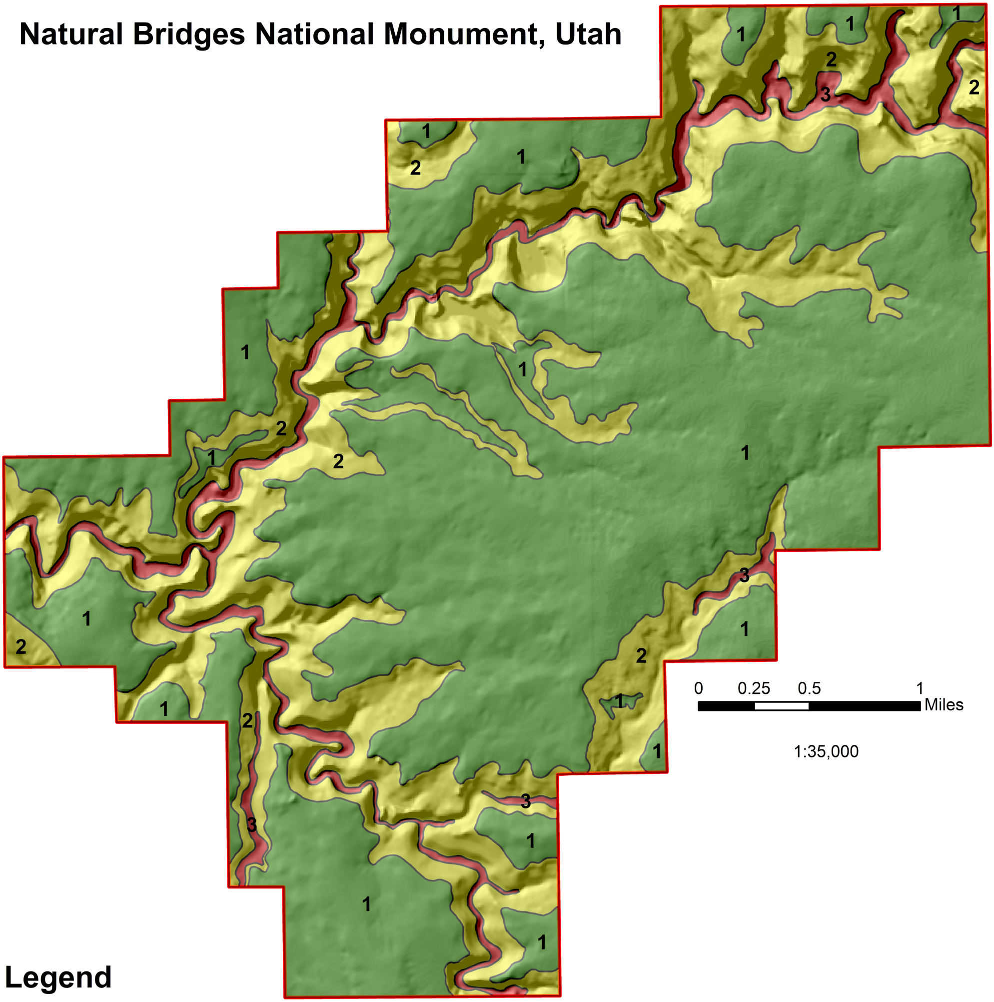
GENERAL SOIL MAP

Natural Bridges National Monument, Utah



Legend

Eolian Deposits on Mesas

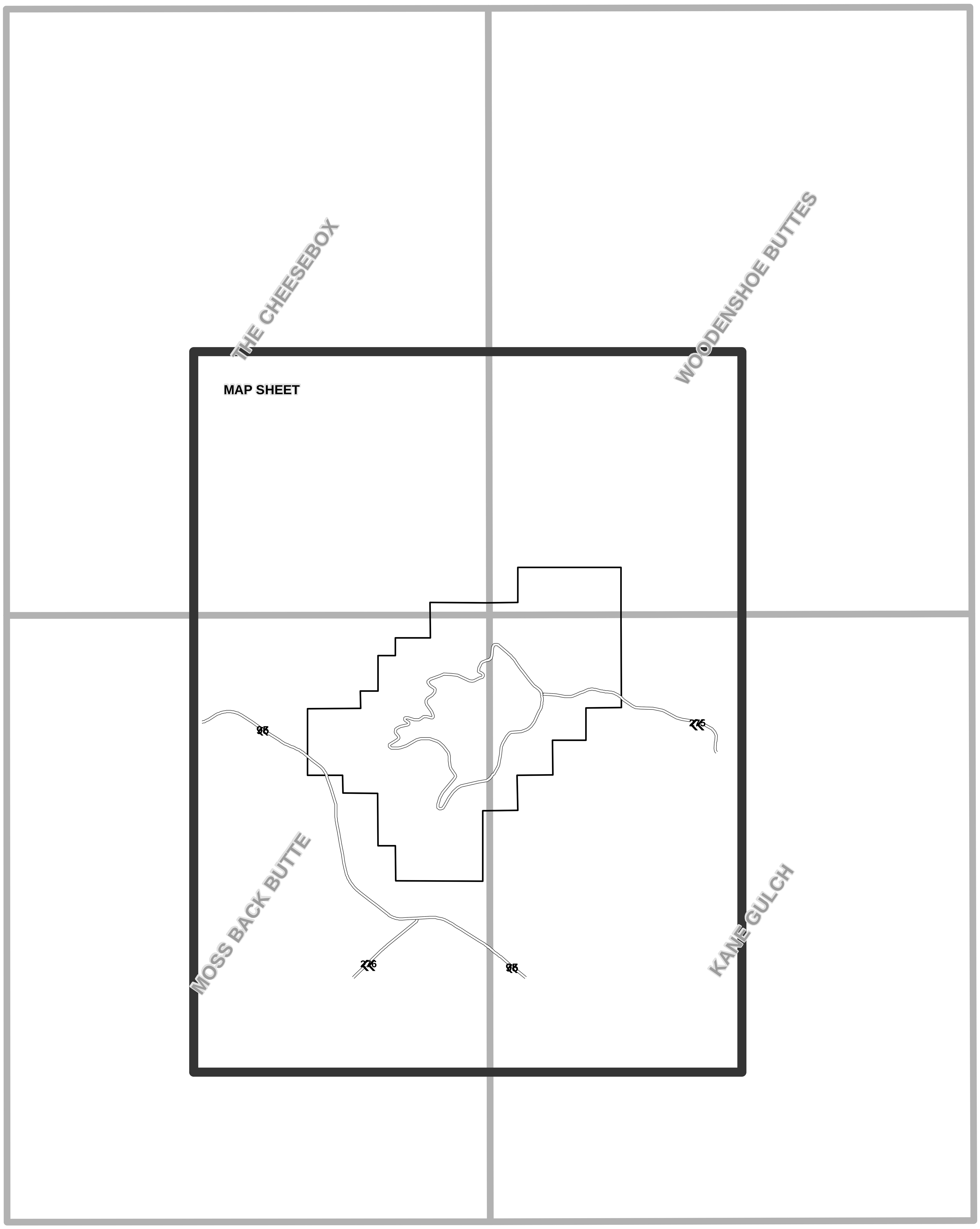
1. Gladel-Plumasano-Rock outcrop association

Rock outcrop, Colluvium, and Shallow Eolian Deposits on Canyon Ledges and Rims

2. Rock outcrop-Bamac-Nizhoni-Metuck association

Alluvium in Canyon Bottoms

3. Levante family complex



INDEX TO MAP SHEET

NATURAL BRIDGES
NATIONAL MONUMENT, UTAH
SOIL SURVEY

0 1 2 3 4 5
Miles

0 1 2 3 4 5
Kilometers

UNITED STATES DEPARTMENT OF AGRICULTURE
NATURAL RESOURCES CONSERVATION SERVICE

NATURAL BRIDGES NATIONAL MONUMENT, UTAH

UNITED STATES DEPARTMENT OF INTERIOR, NATIONAL PARK SERVICE
UTAH AGRICULTURAL EXPERIMENT STATION

SOIL LEGEND

SYMBOL	NAME
69	Nomrah-Plumasano-Gladel complex, 2 to 8 percent slopes
70	Plumasano-Tanoan family-Gladel complex, 2 to 50 percent slopes
71	Gladel-Rock outcrop complex, 5 to 15 percent slopes
72	Rock outcrop-Nizhoni-Bamac complex, 5 to 60 percent slopes
73	Levante family complex, 0 to 15 percent slopes
74	Metuck very gravelly sandy loam, 25 to 65 percent slopes

CONVENTIONAL AND SPECIAL SYMBOLS LEGEND

CULTURAL FEATURES

BOUNDARIES

Limit of soil survey

ROAD EMBLEM & DESIGNATIONS

State 52

SPECIAL SYMBOLS FOR SOIL SURVEY

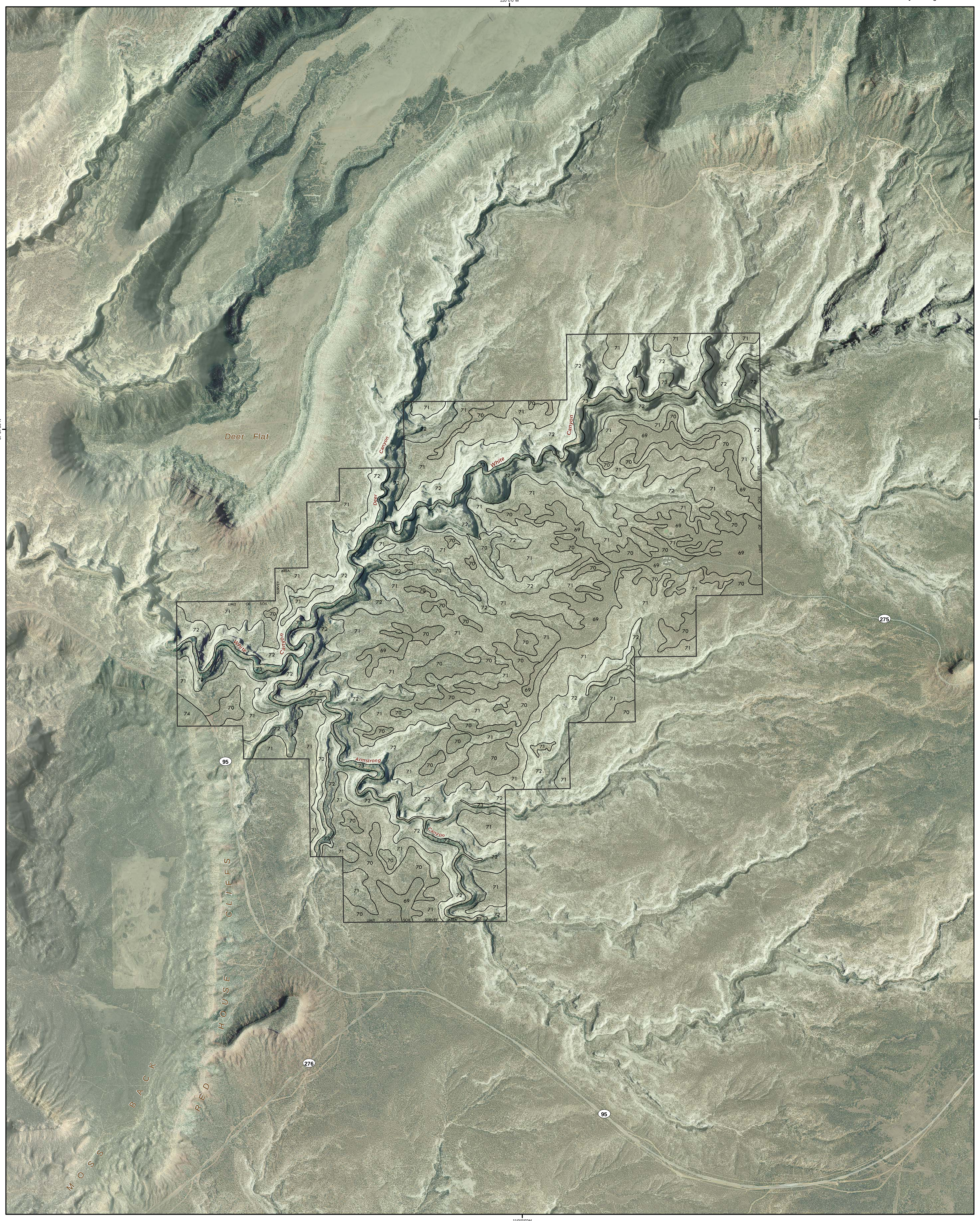
SOIL DELINEATIONS AND SYMBOLS 69 73

United States Department of the Interior
National Park Service

United States Department of Agriculture
Natural Resources Conservation Service

Natural Bridges National Monument Soil Survey

Includes parts of The Cheesebox, Woodenshoe Buttes, Moss Back Butte, and Kane Gulch Quadrangles.



GIS Layer Sources

Image:
USDA/NRCS
Digital Orthophoto, 2006
Draped over 10 Meter NED
Hillshade - USDA/NRCS

Park Boundary:
National Park Service, 2008.

Soil Data:
Natural Resources Conservation Service
Digital Soil Survey of Natural Bridges
National Monument, February, 2009.

NRCS Natural Resources Conservation Service

1:24,000

0 1 2 3 Miles

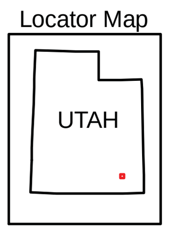
0 1 2 3 4 Kilometers

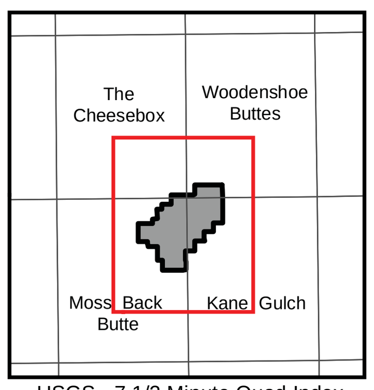
Natural Bridges National Monument
Soil Survey

Projection: UTM Zone 12
Datum: NAD83

N
W E
S

Locator Map





USGS - 7 1/2 Minute Quad Index